



Test Report issued under the responsibility of:



TEST REPORT

IEC 62368-1

Audio/video, information and communication technology equipment

Part 1: Safety requirements

Report Number: E322375-A6027-CB-1

Date of issue: 2024-06-21

Total number of pages: 55

Name of Testing Laboratory
preparing the Report: UL Solutions Melville

Applicant's name: DIODES INC
Address: SUITE 200
4949 HEDGCOXE RD
PLANO TX 75024
UNITED STATES

Test specification:

Standard: IEC 62368-1: 2018

Test procedure: CB Scheme

Non-standard test method: N/A

TRF template used: IECEE OD-2020-F1:2021, Ed.1.4

Test Report Form No: IEC62368_1E

Test Report Form(s) Originator...: UL(US)

Master TRF: Dated 2022-04-14

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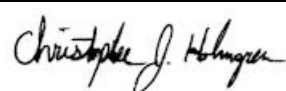
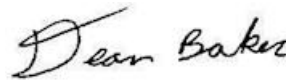
If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results presented in this report relate only to the object tested.

This report shall not be reproduced, except in full, without the written approval of the Issuing CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

Test Item Description	IC Current Limiter	
Trade Mark(s)		
Manufacturer	DIODES INC SUITE 200 4949 HEDGCOXE RD PLANO TX 75024 UNITED STATES	
Model/Type reference	AP21X2A, Where X can be 4,5,6,7,8 or 9, followed by XX and it can be MP or S or FGE, and followed by G-X where X is 13 or 7.	
Ratings	(Markings Optional) Input Voltage: 2.7 - 5.5Vdc Output Continuous Rating: 0.5A to 3.0A Output Current Limit: 1.0 to 4.8A Operating Temperature: -40C to 85C Number of Outputs: 2	
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input checked="" type="checkbox"/> CB Testing Laboratory:		
Testing location/ address	UL Solutions Melville 1285 Walt Whitman Road, Melville, NY, 11747, USA	
Tested by (name, function, signature)..... :	Christopher Holmgren / Project Handler	
Approved by (name, function, signature) .. :	Dean Baker / Reviewer	
Testing procedure: CTF Stage 1:		
Testing location/ address		
Tested by (name, function, signature)..... :		
Approved by (name, function, signature) .. :		
Testing procedure: CTF Stage 2:		
Testing location/ address		
Tested by (name, function, signature)..... :		
Witnessed by (name, function, signature) . :		

Approved by (name, function, signature) .. :			
<input type="checkbox"/>	Testing procedure: CTF Stage 3:		
<input type="checkbox"/>	Testing procedure: CTF Stage 4:		
Testing location/ address :			
Tested by (name, function, signature)..... :			
Witnessed by (name, function, signature) . :			
Approved by (name, function, signature) .. :			
Supervised by (name, function, signature) :			

List of Attachments (including a total number of pages in each attachment):

National Differences (8 pages)

Enclosures (56 pages)

Summary of testing:**Tests performed (name of test and test clause):**B.2.6, 5.4.1.4, 6.3, 9.3, B.1.5 – NORMAL
OPERATING CONDITIONS TEMPERATURE
MEASUREMENTB.3 – SIMULATED ABNORMAL OPERATING
CONDITIONS

B.4 – SIMULATED SINGLE FAULT CONDITIONS

G.9 – IC CURRENT LIMITERS

Testing Location:

Unless otherwise noted, test are all conducted in

CBTL: UL Solutions Melville**1285 Walt Whitman Road, Melville, NY, 11747, USA****Summary of compliance with National Differences (List of countries addressed):**

United States of America - US, Canada - CA

☒ **The product fulfils the requirements of CSA/UL 62368-1:2019****Use of uncertainty of measurement for decisions on conformity (decision rule) :**☒ No decision rule is specified by the IEC standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty ("simple acceptance" decision rule, previously known as "accuracy method").☐ Other:... (to be specified, for example when required by the standard or client, or if national accreditation requirements apply)**Information on uncertainty of measurement:**

The uncertainties of measurement are calculated by the laboratory based on application of criteria given by OD-5014 for test equipment and application of test methods, decision sheets and operational procedures of IECCE. IEC Guide 115 provides guidance on the application of measurement uncertainty principles and applying the decision rule when reporting test results within IECCE scheme, noting that the reporting of the measurement uncertainty for measurements is not necessary unless required by the test standard or customer.

Calculations leading to the reported values are on file with the NCB and testing laboratory that conducted the testing.

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

DIODES

INCORPORATED

AP2142A/ AP2152A

Marking Information

(1) SO-8

(Top view)

8765

Logo

Part Number

4 : Active Low

5 : Active High

1234

AP21XXA

YYWWXX

2 : 2 Channel

YY : Year : 08, 09, 10~

WW : Week : 01~52; 52 represents 52 and 53 week

X : Internal Code

G : Green

(2) MSOP-8EP

(Top view)

8765

Logo

Part Number

4 : Active Low

5 : Active High

1234

AP21X2A

YWXE

A~Z : Green

MSOP-8EP

Y : Year : 0~9

W : Week : A~Z : 1~26 week; a~z : 27~52 week; z represents 52 and 53 week

2 : 2 Channel

(3) U-DFN3030-8

(Top View)

XX

YY

WWX

XX : Identification Code

Y : Year : 0~9

W : Week : A~Z : 1~26 week; a~z : 27~52 week; z represents 52 and 53 week

X : A~Z : Green

Part Number	Package	Identification Code
AP2142AFGEG-7	U-DFN3030-8	AA
AP2152AFGEG-7	U-DFN3030-8	AB

AP2142A/ AP2152A

Document number: DS32191 Rev. 3 - 2

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www.diodes.com

March 2013

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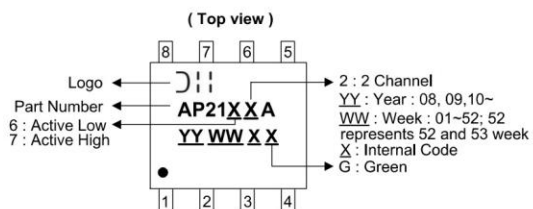
TRF No. IEC62368_1E



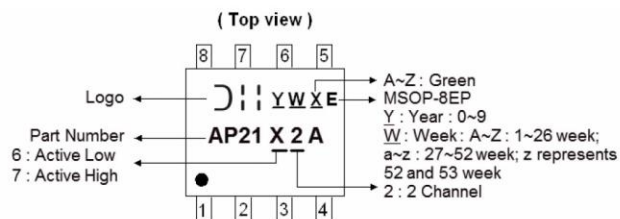
AP2162A/ AP2172A

Marking Information

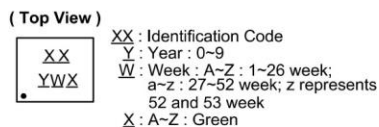
(1) SO-8



(2) MSOP-8EP



(3) U-DFN3030-8



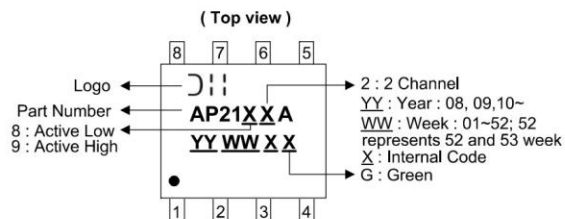
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AP2162AFGEG-7	U-DFN3030-8	AA
AP2172AFGEG-7	U-DFN3030-8	AB



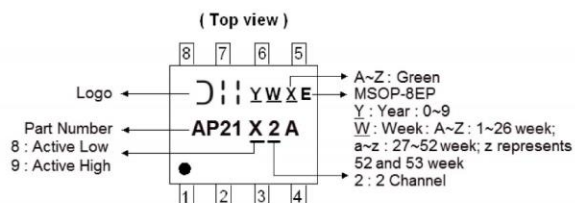
AP2182A/ AP2192A

Marking Information

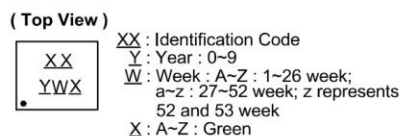
(1) SO-8



(2) MSOP-8EP



(3) U-DFN3030-8 (Type E)



Part Number	Package	Identification Code
AP2182AFGEG-7	U-DFN3030-8 (Type E)	AE
AP2192AFGEG-7	U-DFN3030-8 (Type E)	AF

Note: The above markings are the minimum requirements required by the safety lab. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.

Test item particulars:	
Product group	built-in component
Classification of use by	Ordinary person
Supply Connection	not mains connected: ES1
Supply tolerance	None
Supply connection – type	N/A
Considered current rating of protective device	N/A A;
Equipment mobility	for building-in
Over voltage category (OVC)	OVC I
Class of equipment	Class III
Special installation location	N/A
Pollution degree (PD)	PD 2
Manufacturer's specified Tma (°C)	85°C
IP protection class	IPX0
Power systems	not AC mains
Altitude during operation (m)	2000 m or less
Altitude of test laboratory (m)	2000 m or less
Mass of equipment (kg)	<0.1kg
Possible test case verdicts:	
- test case does not apply to the test object	N/A
- test object does meet the requirement	P (Pass)
- test object does not meet the requirement	F (Fail)
Testing:	
Date of receipt of test item	2024-01-22, 2010-03-30
Date (s) of performance of tests	2024-01-31 to 2024-02-27, 2010-03-30
General remarks:	
"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report. Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.	
Manufacturer's Declaration per sub-clause 4.2.5 of IEC 60335-1:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided :	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies) : Diodes Shanghai Co., Ltd.
No 1 Lane 18, San Zhuang Road, Songjiang
Shanghai, 201600, P.R.
China

General product information and other remarks:

Product Description

The component power distribution switch (IC Current Limiter) limits the output current to within the specified output ratings. These devices provide current limiting and short-circuit protection when supplied by a power source (e.g., 250 VA) in accordance with those specified for LPS outputs. These devices are for use in ES1 circuits only.

Model Differences

Model AP2142A is identical to Model AP2152A except Model AP2142A is Enable Active Low while Model AP2152A is Enable Active high.

Model AP2162A is identical to Model AP2172A except Model AP2162A is Enable Active Low while Model AP2172A is Enable Active high.

Model AP2182A is identical to Model AP2192A except Model AP2182A is Enable Active Low while Model AP2192A is Enable Active high.

Additional Information

Manufacturer's Specification Sheet is available per request.

MARKING: The Recognized Company, trade name (Diodes), trademark, catalog number, and Recognized Component Mark on the smallest package or reel. Electrical ratings, including voltage range, maximum continuous current, protective current and operating temperatures shall be provided on the manufacturer's device specific datasheet. Electrical ratings are optional. The datasheet maybe web-based provided it is publicly accessible on the internet.

Technical Considerations

- The product was submitted and evaluated for use at the maximum ambient temperature (Tma) permitted by the manufacturer's specification of : 85°C

Engineering Conditions of Acceptability

When installed in an end-product, consideration must be given to the following:

- These devices are integrated circuits and electrical spacings within the device are not specified.
- These devices are entirely electronic in nature and have no means for manual operation or reset.
- The terminals of these devices are for factory wiring only and are intended to be mounted on printed wiring board.
- These devices have only been evaluated for supplementary overcurrent protection of secondary circuits supplied by the load side of a transformer or battery, and have not been evaluated for branch-circuit protection.
- Use on secondary supply circuits with a higher power capability requires additional evaluation for reliability, such as are contained in the Standard for Safety-Related Controls Employing Solid-State Controls, UL 991.
- These devices limit currents to values less than the overcurrent protection rating of 5 amperes.
- These devices have not been subjected Tests for Telecom applications and their suitability for connection to telecommunication networks with outside plant connections should be determined in the end-use.
- These devices were evaluated with respect to continuous current operation at the current levels shown in the electrical ratings section of this report.

OVERVIEW OF ENERGY SOURCES AND SAFEGUARDS				
Clause	Possible Hazard			
5	Electrically-caused injury			
Class and Energy Source (e.g. ES3: Primary circuit)	Body Part (e.g. Ordinary)	Safeguards		
		B	S	R
ES1: Input Circuits	Ordinary	N/A	N/A	N/A
ES1: Output Circuits	Ordinary	N/A	N/A	N/A
6	Electrically-caused fire			
Class and Energy Source (e.g. PS2: 100 Watt circuit)	Material part (e.g. Printed board)	Safeguards		
		B	1 st S	2 nd S
PS2	Output Circuits	See sub-clause 6.3.	For building-in. The relevant energy to be evaluated in end-product.	N/A
7	Injury caused by hazardous substances			
Class and Energy Source (e.g. Ozone)	Body Part (e.g., Skilled)	Safeguards		
		B	S	R
N/A	N/A	N/A	N/A	N/A
8	Mechanically-caused injury			
Class and Energy Source (e.g. MS3: Plastic fan blades)	Body Part (e.g. Ordinary)	Safeguards		
		B	S	R
N/A	N/A	N/A	N/A	N/A
9	Thermal burn			
Class and Energy Source (e.g. TS1: Keyboard caps)	Body Part (e.g., Ordinary)	Safeguards		
		B	S	R
N/A (For building-in. The relevant energy to be evaluated in end-product.)	N/A	N/A	N/A	N/A
10	Radiation			
Class and Energy Source (e.g. RS1: PMP sound output)	Body Part (e.g., Ordinary)	Safeguards		
		B	S	R
N/A	N/A	N/A	N/A	N/A
Supplementary Information:				
“B” – Basic Safeguard; “S” – Supplementary Safeguard; “R” – Reinforced Safeguard				

ENERGY SOURCE DIAGRAM

Optional. Manufacturers are to provide the energy sources diagram identify declared energy sources and identifying the demarcations are between power sources. Recommend diagram be provided included in power supply and multipart systems.

Insert diagram below. Example diagram designs are; Block diagrams; image(s) with layered data; mechanical drawings

☐ **ES** ☐ **PS** ☐ **MS** ☐ **TS** ☐ **RS**

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
4	GENERAL REQUIREMENTS		Pass
4.1.1	Acceptance of materials, components and subassemblies		Pass
4.1.2	Use of components		Pass
4.1.3	Equipment design and construction		Pass
4.1.4	Specified ambient temperature for outdoor use (°C):		N/A
4.1.5	Constructions and components not specifically covered		N/A
4.1.8	Liquids and liquid filled components (LFC)		N/A
4.1.15	Markings and instructions	(See Annex F)	Pass
4.4.3	Safeguard robustness		N/A
4.4.3.1	General		N/A
4.4.3.2	Steady force tests		N/A
4.4.3.3	Drop tests		N/A
4.4.3.4	Impact tests		N/A
4.4.3.5	Internal accessible safeguard tests		N/A
4.4.3.6	Glass impact tests		N/A
4.4.3.7	Glass fixation tests		N/A
	Glass impact test (1J)		N/A
	Push/pull test (10 N)		N/A
4.4.3.8	Thermoplastic material tests		N/A
4.4.3.9	Air comprising a safeguard		N/A
4.4.3.10	Accessibility, glass, safeguard effectiveness		N/A
4.4.4	Displacement of a safeguard by an insulating liquid		N/A
4.4.5	Safety interlocks		N/A
4.5	Explosion		N/A
4.5.1	General		N/A
4.5.2	No explosion during normal/abnormal operating condition		N/A
	No harm by explosion during single fault conditions		N/A
4.6	Fixing of conductors		N/A
	Fix conductors not to defeat a safeguard		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Compliance is checked by test..... :		N/A
4.7	Equipment for direct insertion into mains socket-outlets		N/A
4.7.2	Mains plug part complies with relevant standard .. :		N/A
4.7.3	Torque (Nm) :		N/A
4.8	Equipment containing coin/button cell batteries		N/A
4.8.1	General		N/A
4.8.2	Instructional safeguard :		N/A
4.8.3	Battery compartment door/cover construction		N/A
	Open torque test		N/A
4.8.4.2	Stress relief test		N/A
4.8.4.3	Battery replacement test		N/A
4.8.4.4	Drop test		N/A
4.8.4.5	Impact test		N/A
4.8.4.6	Crush test		N/A
4.8.5	Compliance		N/A
	30N force test with test probe		N/A
	20N force test with test hook		N/A
4.9	Likelihood of fire or shock due to entry of conductive object		N/A
4.10	Component requirements		N/A
4.10.1	Disconnect Device		N/A
4.10.2	Switches and relays		N/A

5	ELECTRICALLY-CAUSED INJURY		Pass
5.2	Classification and limits of electrical energy sources		N/A
5.2.2	ES1, ES2 and ES3 limits	Outputs complied with ES1.	N/A
5.2.2.2	Steady-state voltage and current limits :		N/A
5.2.2.3	Capacitance limits :		N/A
5.2.2.4	Single pulse limits :		N/A
5.2.2.5	Limits for repetitive pulses :		N/A
5.2.2.6	Ring signals		N/A
5.2.2.7	Audio signals		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
5.3	Protection against electrical energy sources		N/A
5.3.1	General Requirements for accessible parts to ordinary, instructed and skilled persons	For building-in. To be evaluated in end-product.	N/A
5.3.1 a)	Accessible ES1/ES2 derived from ES2/ES3 circuits		N/A
5.3.1 b)	Skilled persons not unintentional contact ES3 bare conductors		N/A
5.3.2.1	Accessibility to electrical energy sources and safeguards		N/A
	Accessibility to outdoor equipment bare parts		N/A
5.3.2.2	Contact requirements		N/A
	Test with test probe from Annex V		—
5.3.2.2 a)	Air gap – electric strength test potential (V)		N/A
5.3.2.2 b)	Air gap – distance (mm)		N/A
5.3.2.3	Compliance		N/A
5.3.2.4	Terminals for connecting stripped wire		N/A
5.4	Insulation materials and requirements		Pass
5.4.1.2	Properties of insulating material		Pass
5.4.1.3	Material is non-hygroscopic		N/A
5.4.1.4	Maximum operating temperature for insulating materials	(See Table 5.4.1.4, 9.3, B.1.5, B.2.6)	Pass
5.4.1.5	Pollution degrees	PD 2	Pass
5.4.1.5.2	Test for pollution degree 1 environment and for an insulating compound		N/A
5.4.1.5.3	Thermal cycling test		N/A
5.4.1.6	Insulation in transformers with varying dimensions		N/A
5.4.1.7	Insulation in circuits generating starting pulses		N/A
5.4.1.8	Determination of working voltage		N/A
5.4.1.9	Insulating surfaces		N/A
5.4.1.10	Thermoplastic parts on which conductive metallic parts are directly mounted		N/A
5.4.1.10.2	Vicat test		N/A
5.4.1.10.3	Ball pressure test		N/A
5.4.2	Clearances		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
5.4.2.1	General requirements		N/A
	Clearances in circuits connected to AC Mains, Alternative method		N/A
5.4.2.2	Procedure 1 for determining clearance		N/A
	Temporary overvoltage		—
5.4.2.3	Procedure 2 for determining clearance		N/A
5.4.2.3.2.2	a.c. mains transient voltage		—
5.4.2.3.2.3	d.c. mains transient voltage		—
5.4.2.3.2.4	External circuit transient voltage.....		—
5.4.2.3.2.5	Transient voltage determined by measurement		—
5.4.2.4	Determining the adequacy of a clearance using an electric strength test		N/A
5.4.2.5	Multiplication factors for clearances and test voltages		N/A
5.4.2.6	Clearance measurement		N/A
5.4.3	Creepage distances		N/A
5.4.3.1	General		N/A
5.4.3.3	Material group		—
5.4.3.4	Creepage distances measurement		N/A
5.4.4	Solid insulation		N/A
5.4.4.1	General requirements		N/A
5.4.4.2	Minimum distance through insulation		N/A
5.4.4.3	Insulating compound forming solid insulation		N/A
5.4.4.4	Solid insulation in semiconductor devices		N/A
5.4.4.5	Insulating compound forming cemented joints		N/A
5.4.4.6	Thin sheet material		N/A
5.4.4.6.1	General requirements		N/A
5.4.4.6.2	Separable thin sheet material		N/A
	Number of layers (pcs)		N/A
5.4.4.6.3	Non-separable thin sheet material		N/A
	Number of layers (pcs)		N/A
5.4.4.6.4	Standard test procedure for non-separable thin sheet material		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
5.4.4.6.5	Mandrel test		N/A
5.4.4.7	Solid insulation in wound components		N/A
5.4.4.9	Solid insulation at frequencies >30 kHz, E_P , K_R , d , V_{PW} (V)		N/A
	Alternative by electric strength test, tested voltage (V), K_R		N/A
5.4.5	Antenna terminal insulation		N/A
5.4.5.1	General		N/A
5.4.5.2	Voltage surge test		N/A
5.4.5.3	Insulation resistance ($M\Omega$)		N/A
	Electric strength test.....		N/A
5.4.6	Insulation of internal wire as part of supplementary safeguard		N/A
5.4.7	Tests for semiconductor components and for cemented joints		N/A
5.4.8	Humidity conditioning		N/A
	Relative humidity (%), temperature ($^{\circ}C$), duration (h).....		—
5.4.9	Electric strength test		N/A
5.4.9.1	Test procedure for type test of solid insulation.....		N/A
5.4.9.2	Test procedure for routine test		N/A
5.4.10	Safeguards against transient voltages from external circuits		N/A
5.4.10.1	Parts and circuits separated from external circuits		N/A
5.4.10.2	Test methods		N/A
5.4.10.2.1	General		N/A
5.4.10.2.2	Impulse test		N/A
5.4.10.2.3	Steady-state test.....		N/A
5.4.10.3	Verification for insulation breakdown for impulse test		N/A
5.4.11	Separation between external circuits and earth		N/A
5.4.11.1	Exceptions to separation between external circuits and earth		N/A
5.4.11.2	Requirements		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
	SPDs bridge separation between external circuit and earth		N/A
	Rated operating voltage U_{op} (V)		—
	Nominal voltage U_{peak} (V)		—
	Max increase due to variation ΔU_{sp}		—
	Max increase due to ageing ΔU_{sa}		—
5.4.11.3	Test method and compliance		N/A
5.4.12	Insulating liquid		N/A
5.4.12.1	General requirements		N/A
5.4.12.2	Electric strength of an insulating liquid		N/A
5.4.12.3	Compatibility of an insulating liquid		N/A
5.4.12.4	Container for insulating liquid		N/A
5.5	Components as safeguards		N/A
5.5.1	General		N/A
5.5.2	Capacitors and RC units		N/A
5.5.2.1	General requirement		N/A
5.5.2.2	Safeguards against capacitor discharge after disconnection of a connector		N/A
5.5.3	Transformers		N/A
5.5.4	Optocouplers		N/A
5.5.5	Relays		N/A
5.5.6	Resistors		N/A
5.5.7	SPDs		N/A
5.5.8	Insulation between the mains and an external circuit consisting of a coaxial cable		N/A
5.5.9	Safeguards for socket-outlets in outdoor equipment		N/A
	RCD rated residual operating current (mA)		—
5.6	Protective conductor		N/A
5.6.2	Requirement for protective conductors		N/A
5.6.2.1	General requirements		N/A
5.6.2.2	Colour of insulation		N/A
5.6.3	Requirement for protective earthing conductors		N/A

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Protective earthing conductor size (mm ²) :		—
	Protective earthing conductor serving as a reinforced safeguard		N/A
	Protective earthing conductor serving as a double safeguard		N/A
5.6.4	Requirements for protective bonding conductors		N/A
5.6.4.1	Protective bonding conductors		N/A
	Protective bonding conductor size (mm ²). :		—
5.6.4.2	Protective current rating (A) :		N/A
5.6.5	Terminals for protective conductors		N/A
5.6.5.1	Terminal size for connecting protective earthing conductors (mm) :		N/A
	Terminal size for connecting protective bonding conductors (mm) :		N/A
5.6.5.2	Corrosion		N/A
5.6.6	Resistance of the protective bonding system		N/A
5.6.6.1	Requirements		N/A
5.6.6.2	Test Method :		N/A
5.6.6.3	Resistance (Ω) or voltage drop :		N/A
5.6.7	Reliable connection of a protective earthing conductor		N/A
5.6.8	Functional earthing		N/A
	Conductor size (mm ²) :		N/A
	Class II with functional earthing marking :		N/A
	Appliance inlet cl & cr (mm) :		N/A
5.7	Prospective touch voltage, touch current and protective conductor current		N/A
5.7.2	Measuring devices and networks		N/A
5.7.2.1	Measurement of touch current		N/A
5.7.2.2	Measurement of voltage		N/A
5.7.3	Equipment set-up, supply connections and earth connections		N/A
5.7.4	Unearthed accessible parts :		N/A
5.7.5	Earthed accessible conductive parts :		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
5.7.6	Requirements when touch current exceeds ES2 limits		N/A
	Protective conductor current (mA)		N/A
	Instructional Safeguard		N/A
5.7.7	Prospective touch voltage and touch current associated with external circuits		N/A
5.7.7.1	Touch current from coaxial cables		N/A
5.7.7.2	Prospective touch voltage and touch current associated with paired conductor cables		N/A
5.7.8	Summation of touch currents from external circuits		N/A
	a) Equipment connected to earthed external circuits, current (mA)		N/A
	b) Equipment connected to unearthed external circuits, current (mA)		N/A
5.8	Backfeed safeguard in battery backed up supplies		N/A
	Mains terminal ES		N/A
	Air gap (mm)		N/A
6	ELECTRICALLY- CAUSED FIRE		Pass
6.2	Classification of PS and PIS		N/A
6.2.2	Power source circuit classifications		N/A
6.2.3	Classification of potential ignition sources		N/A
6.2.3.1	Arcing PIS		N/A
6.2.3.2	Resistive PIS		N/A
6.3	Safeguards against fire under normal operating and abnormal operating conditions		Pass
6.3.1	No ignition and attainable temperature value less than 90 % defined by ISO 871 or less than 300 °C for unknown materials.....	(See Table 5.4.1.4, 9.3, B.1.5, B.2.6)	Pass
	Combustible materials outside fire enclosure		N/A
6.4	Safeguards against fire under single fault conditions		N/A
6.4.1	Safeguard method	Control of fire spread method used.	N/A
6.4.2	Reduction of the likelihood of ignition under single fault conditions in PS1 circuits		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
6.4.3	Reduction of the likelihood of ignition under single fault conditions in PS2 and PS3 circuits		N/A
6.4.3.1	Supplementary safeguards		N/A
6.4.3.2	Single Fault Conditions..... :	(See Table B.3, B.4)	N/A
	Special conditions for temperature limited by fuse		N/A
6.4.4	Control of fire spread in PS1 circuits		N/A
6.4.5	Control of fire spread in PS2 circuits		N/A
6.4.5.2	Supplementary safeguards		N/A
6.4.6	Control of fire spread in PS3 circuits		N/A
6.4.7	Separation of combustible materials from a PIS		N/A
6.4.7.2	Separation by distance		N/A
6.4.7.3	Separation by a fire barrier		N/A
6.4.8	Fire enclosures and fire barriers		N/A
6.4.8.2	Fire enclosure and fire barrier material properties		N/A
6.4.8.2.1	Requirements for a fire barrier		N/A
6.4.8.2.2	Requirements for a fire enclosure		N/A
6.4.8.3	Constructional requirements for a fire enclosure and a fire barrier		N/A
6.4.8.3.1	Fire enclosure and fire barrier openings		N/A
6.4.8.3.2	Fire barrier dimensions		N/A
6.4.8.3.3	Top openings and properties		N/A
	Openings dimensions (mm)..... :		N/A
6.4.8.3.4	Bottom openings and properties		N/A
	Openings dimensions (mm)..... :		N/A
	Flammability tests for the bottom of a fire enclosure		N/A
	Instructional Safeguard..... :		N/A
6.4.8.3.5	Side openings and properties		N/A
	Openings dimensions (mm)..... :		N/A
6.4.8.3.6	Integrity of a fire enclosure, condition met: a), b) or c)..... :		N/A
6.4.8.4	Separation of a PIS from a fire enclosure and a fire barrier distance (mm) or flammability rating :		N/A
6.4.9	Flammability of insulating liquid..... :		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
6.5	Internal and external wiring		N/A
6.5.1	General requirements		N/A
6.5.2	Requirements for interconnection to building wiring :		N/A
6.5.3	Internal wiring size (mm ²) for socket-outlets..... :		N/A
6.6	Safeguards against fire due to the connection to additional equipment		N/A
7	INJURY CAUSED BY HAZARDOUS SUBSTANCES		N/A
7.2	Reduction of exposure to hazardous substances		N/A
7.3	Ozone exposure		N/A
7.4	Use of personal safeguards or personal protective equipment (PPE)		N/A
	Personal safeguards and instructions :		—
7.5	Use of instructional safeguards and instructions		N/A
	Instructional safeguard (ISO 7010)..... :		—
7.6	Batteries and their protection circuits		N/A
8	MECHANICALLY-CAUSED INJURY		N/A
8.2	Mechanical energy source classifications		N/A
8.3	Safeguards against mechanical energy sources		N/A
8.4	Safeguards against parts with sharp edges and corners		N/A
8.4.1	Safeguards		N/A
	Instructional Safeguard..... :		N/A
8.4.2	Sharp edges or corners		N/A
8.5	Safeguards against moving parts		N/A
8.5.1	Fingers, jewellery, clothing, hair, etc., contact with MS2 or MS3 parts		N/A
	MS2 or MS3 part required to be accessible for the function of the equipment		N/A
	Moving MS3 parts only accessible to skilled person		N/A
8.5.2	Instructional safeguard..... :		N/A
8.5.4	Special categories of equipment containing moving parts		N/A
8.5.4.1	General		N/A
8.5.4.2	Equipment containing work cells with MS3 parts		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
8.5.4.2.1	Protection of persons in the work cell		N/A
8.5.4.2.2	Access protection override		N/A
8.5.4.2.2.1	Override system		N/A
8.5.4.2.2.2	Visual indicator		N/A
8.5.4.2.3	Emergency stop system		N/A
	Maximum stopping distance from the point of activation (m).....:		N/A
	Space between end point and nearest fixed mechanical part (mm)		N/A
8.5.4.2.4	Endurance requirements		N/A
	Mechanical system subjected to 100 000 cycles of operation		N/A
	- Mechanical function check and visual inspection		N/A
	- Cable assembly		N/A
8.5.4.3	Equipment having electromechanical device for destruction of media		N/A
8.5.4.3.1	Equipment safeguards		N/A
8.5.4.3.2	Instructional safeguards against moving parts.....:		N/A
8.5.4.3.3	Disconnection from the supply		N/A
8.5.4.3.4	Cut type and test force (N).....:		N/A
8.5.4.3.5	Compliance		N/A
8.5.5	High pressure lamps		N/A
	Explosion test		N/A
8.5.5.3	Glass particles dimensions (mm)		N/A
8.6	Stability of equipment		N/A
8.6.1	General		N/A
	Instructional safeguard.....:		N/A
8.6.2	Static stability		N/A
8.6.2.2	Static stability test.....:		N/A
8.6.2.3	Downward force test		N/A
8.6.3	Relocation stability		N/A
	Wheels diameter (mm).....:		—
	Tilt test		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
8.6.4	Glass slide test		N/A
8.6.5	Horizontal force test		N/A
8.7	Equipment mounted to wall, ceiling or other structure		N/A
8.7.1	Mount means type.....		N/A
8.7.2	Test methods		N/A
	Test 1, additional downwards force (N).....		N/A
	Test 2, number of attachment points and test force (N)		N/A
	Test 3 Nominal diameter (mm) and applied torque (Nm)		N/A
8.8	Handles strength		N/A
8.8.1	General		N/A
8.8.2	Handle strength test		N/A
	Number of handles.....		—
	Force applied (N)		—
8.9	Wheels or casters attachment requirements		N/A
8.9.2	Pull test		N/A
8.10	Carts, stands and similar carriers		N/A
8.10.1	General		N/A
8.10.2	Marking and instructions		N/A
8.10.3	Cart, stand or carrier loading test		N/A
	Loading force applied (N)		N/A
8.10.4	Cart, stand or carrier impact test		N/A
8.10.5	Mechanical stability		N/A
	Force applied (N)		—
8.10.6	Thermoplastic temperature stability		N/A
8.11	Mounting means for slide-rail mounted equipment (SRME)		N/A
8.11.1	General		N/A
8.11.2	Requirements for slide rails		N/A
	Instructional Safeguard		N/A
8.11.3	Mechanical strength test		N/A
8.11.3.1	Downward force test, force (N) applied		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
8.11.3.2	Lateral push force test		N/A
8.11.3.3	Integrity of slide rail end stops		N/A
8.11.4	Compliance		N/A
8.12	Telescoping or rod antennas		N/A
	Button/ball diameter (mm)		—

9	THERMAL BURN INJURY		N/A
9.2	Thermal energy source classifications		N/A
9.3	Touch temperature limits		N/A
9.3.1	Touch temperatures of accessible parts		N/A
9.3.2	Test method and compliance		N/A
9.4	Safeguards against thermal energy sources		N/A
9.5	Requirements for safeguards		N/A
9.5.1	Equipment safeguard		N/A
9.5.2	Instructional safeguard.....		N/A
9.6	Requirements for wireless power transmitters		N/A
9.6.1	General		N/A
9.6.2	Specification of the foreign objects		N/A
9.6.3	Test method and compliance		N/A

10	RADIATION		N/A
10.2	Radiation energy source classification		N/A
10.2.1	General classification		N/A
	Lasers		—
	Lamps and lamp systems		—
	Image projectors		—
	X-Ray		—
	Personal music player		—
10.3	Safeguards against laser radiation		N/A
	The standard(s) equipment containing laser(s) comply		N/A
10.4	Safeguards against optical radiation from lamps and lamp systems (including LED types)		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
10.4.1	General requirements		N/A
	Instructional safeguard provided for accessible radiation level needs to exceed		N/A
	Risk group marking and location		N/A
	Information for safe operation and installation		N/A
10.4.2	Requirements for enclosures		N/A
	UV radiation exposure		N/A
10.4.3	Instructional safeguard		N/A
10.5	Safeguards against X-radiation		N/A
10.5.1	Requirements		N/A
	Instructional safeguard for skilled persons		—
10.5.3	Maximum radiation (pA/kg)		—
10.6	Safeguards against acoustic energy sources		N/A
10.6.1	General		N/A
10.6.2	Classification		N/A
	Acoustic output $L_{Aeq,T}$, dB(A)		N/A
	Unweighted RMS output voltage (mV)		N/A
	Digital output signal (dBFS)		N/A
10.6.3	Requirements for dose-based systems		N/A
10.6.3.1	General requirements		N/A
10.6.3.2	Dose-based warning and automatic decrease		N/A
10.6.3.3	Exposure-based warning and requirements		N/A
	30 s integrated exposure level (MEL30)		N/A
	Warning for MEL ≥ 100 dB(A)		N/A
10.6.4	Measurement methods		N/A
10.6.5	Protection of persons		N/A
	Instructional safeguards		N/A
10.6.6	Requirements for listening devices (headphones, earphones, etc.)		N/A
10.6.6.1	Corded listening devices with analogue input		N/A
	Listening device input voltage (mV)		N/A
10.6.6.2	Corded listening devices with digital input		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Max. acoustic output $L_{Aeq,T}$, dB(A)		N/A
10.6.6.3	Cordless listening devices		N/A
	Max. acoustic output $L_{Aeq,T}$, dB(A)		N/A
B	NORMAL OPERATING CONDITION TESTS, ABNORMAL OPERATING CONDITION TESTS AND SINGLE FAULT CONDITION TESTS		Pass
B.1	General		N/A
B.1.5	Temperature measurement conditions		N/A
B.2	Normal operating conditions		N/A
B.2.1	General requirements		N/A
	Audio Amplifiers and equipment with audio amplifiers		N/A
B.2.3	Supply voltage and tolerances		N/A
B.2.5	Input test		N/A
B.3	Simulated abnormal operating conditions		N/A
B.3.1	General		N/A
B.3.2	Covering of ventilation openings		N/A
	Instructional safeguard		N/A
B.3.3	DC mains polarity test		N/A
B.3.4	Setting of voltage selector		N/A
B.3.5	Maximum load at output terminals		N/A
B.3.6	Reverse battery polarity		N/A
B.3.7	Audio amplifier abnormal operating conditions		N/A
B.3.8	Safeguards functional during and after abnormal operating conditions.....		N/A
B.4	Simulated single fault conditions		Pass
B.4.1	General		Pass
B.4.2	Temperature controlling device		N/A
B.4.3	Blocked motor test		N/A
B.4.4	Functional insulation		N/A
B.4.4.1	Short circuit of clearances for functional insulation		N/A
B.4.4.2	Short circuit of creepage distances for functional insulation		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
B.4.4.3	Short circuit of functional insulation on coated printed boards		N/A
B.4.5	Short-circuit and interruption of electrodes in tubes and semiconductors		N/A
B.4.6	Short circuit or disconnection of passive components		N/A
B.4.7	Continuous operation of components		N/A
B.4.8	Compliance during and after single fault conditions :	(See Table B.3, B.4)	Pass
B.4.9	Battery charging and discharging under single fault conditions		N/A
C	UV RADIATION		N/A
C.1	Protection of materials in equipment from UV radiation		N/A
C.1.2	Requirements		N/A
C.1.3	Test method		N/A
C.2	UV light conditioning test		N/A
C.2.1	Test apparatus..... :		N/A
C.2.2	Mounting of test samples		N/A
C.2.3	Carbon-arc light-exposure test		N/A
C.2.4	Xenon-arc light-exposure test		N/A
D	TEST GENERATORS		N/A
D.1	Impulse test generators		N/A
D.2	Antenna interface test generator		N/A
D.3	Electronic pulse generator		N/A
E	TEST CONDITIONS FOR EQUIPMENT CONTAINING AUDIO AMPLIFIERS		N/A
E.1	Electrical energy source classification for audio signals		N/A
	Maximum non-clipped output power (W)..... :		—
	Rated load impedance (Ω) :		—
	Open-circuit output voltage (V)..... :		—
	Instructional safeguard :		—
E.2	Audio amplifier normal operating conditions		N/A
	Audio signal source type..... :		—
	Audio output power (W) :		—

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Clause	Requirement + Test	Result - Remark	Verdict
	Audio output voltage (V)		—
	Rated load impedance (Ω)		—
	Requirements for temperature measurement		N/A
E.3	Audio amplifier abnormal operating conditions		N/A
F	EQUIPMENT MARKINGS, INSTRUCTIONS, AND INSTRUCTIONAL SAFEGUARDS		Pass
F.1	General		N/A
	Language		—
F.2	Letter symbols and graphical symbols		N/A
F.2.1	Letter symbols according to IEC60027-1		N/A
F.2.2	Graphic symbols according to IEC, ISO or manufacturer specific		N/A
F.3	Equipment markings		Pass
F.3.1	Equipment marking locations		Pass
F.3.2	Equipment identification markings		Pass
F.3.2.1	Manufacturer identification	See 'Trademark' for details.	Pass
F.3.2.2	Model identification	See 'Models and Ratings' for details.	Pass
F.3.3	Equipment rating markings		N/A
F.3.3.1	Equipment with direct connection to mains		N/A
F.3.3.2	Equipment without direct connection to mains		N/A
F.3.3.3	Nature of the supply voltage		N/A
F.3.3.4	Rated voltage		N/A
F.3.3.5	Rated frequency		N/A
F.3.3.6	Rated current or rated power		N/A
F.3.3.7	Equipment with multiple supply connections		N/A
F.3.4	Voltage setting device		N/A
F.3.5	Terminals and operating devices		N/A
F.3.5.1	Mains appliance outlet and socket-outlet markings		N/A
F.3.5.2	Switch position identification marking		N/A
F.3.5.3	Replacement fuse identification and rating markings		N/A
	Instructional safeguards for neutral fuse		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
F.3.5.4	Replacement battery identification marking..... :		N/A
F.3.5.5	Neutral conductor terminal		N/A
F.3.5.6	Terminal marking location		N/A
F.3.6	Equipment markings related to equipment classification		N/A
F.3.6.1	Class I equipment		N/A
F.3.6.1.1	Protective earthing conductor terminal :		N/A
F.3.6.1.2	Protective bonding conductor terminals :		N/A
F.3.6.2	Equipment class marking..... :		N/A
F.3.6.3	Functional earthing terminal marking :		N/A
F.3.7	Equipment IP rating marking :		N/A
F.3.8	External power supply output marking :		N/A
F.3.9	Durability, legibility and permanence of marking		N/A
F.3.10	Test for permanence of markings		N/A
F.4	Instructions		N/A
	a) Information prior to installation and initial use		N/A
	b) Equipment for use in locations where children not likely to be present		N/A
	c) Instructions for installation and interconnection		N/A
	d) Equipment intended for use only in restricted access area		N/A
	e) Equipment intended to be fastened in place		N/A
	f) Instructions for audio equipment terminals		N/A
	g) Protective earthing used as a safeguard		N/A
	h) Protective conductor current exceeding ES2 limits		N/A
	i) Graphic symbols used on equipment		N/A
	j) Permanently connected equipment not provided with all-pole mains switch		N/A
	k) Replaceable components or modules providing safeguard function		N/A
	l) Equipment containing insulating liquid		N/A
	m) Installation instructions for outdoor equipment		N/A
F.5	Instructional safeguards		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G	COMPONENTS		Pass
G.1	Switches		N/A
G.1.1	General		N/A
G.1.2	Ratings, endurance, spacing, maximum load		N/A
G.1.3	Test method and compliance		N/A
G.2	Relays		N/A
G.2.1	Requirements		N/A
G.2.2	Overload test		N/A
G.2.3	Relay controlling connectors supplying power to other equipment		N/A
G.2.4	Test method and compliance		N/A
G.3	Protective devices		N/A
G.3.1	Thermal cut-offs		N/A
	Thermal cut-outs separately approved according to IEC 60730 with conditions indicated in a) & b)		N/A
	Thermal cut-outs tested as part of the equipment as indicated in c)		N/A
G.3.1.2	Test method and compliance		N/A
G.3.2	Thermal links		N/A
G.3.2.1	a) Thermal links tested separately according to IEC 60691 with specifics		N/A
	b) Thermal links tested as part of the equipment		N/A
G.3.2.2	Test method and compliance		N/A
G.3.3	PTC thermistors		N/A
G.3.4	Overcurrent protection devices		N/A
G.3.5	Safeguards components not mentioned in G.3.1 to G.3.4		N/A
G.3.5.1	Non-resettable devices suitably rated and marking provided		N/A
G.3.5.2	Single faults conditions		N/A
G.4	Connectors		N/A
G.4.1	Spacings		N/A
G.4.2	Mains connector configuration.....		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G.4.3	Plug is shaped that insertion into mains socket-outlets or appliance coupler is unlikely		N/A
G.5	Wound components		N/A
G.5.1	Wire insulation in wound components		N/A
G.5.1.2	Protection against mechanical stress		N/A
G.5.2	Endurance test		N/A
G.5.2.1	General test requirements		N/A
G.5.2.2	Heat run test		N/A
	Test time (days per cycle)..... :		—
	Test temperature (°C) :		—
G.5.2.3	Wound components supplied from the mains		N/A
G.5.2.4	No insulation breakdown		N/A
G.5.3	Transformers		N/A
G.5.3.1	Compliance method..... :		N/A
	Position :		N/A
	Method of protection :		N/A
G.5.3.2	Insulation		N/A
	Protection from displacement of windings :		—
G.5.3.3	Transformer overload tests		N/A
G.5.3.3.1	Test conditions		N/A
G.5.3.3.2	Winding temperatures		N/A
G.5.3.3.3	Winding temperatures - alternative test method		N/A
G.5.3.4	Transformers using FIW		N/A
G.5.3.4.1	General		N/A
	FIW wire nominal diameter :		—
G.5.3.4.2	Transformers with basic insulation only		N/A
G.5.3.4.3	Transformers with double insulation or reinforced insulation..... :		N/A
G.5.3.4.4	Transformers with FIW wound on metal or ferrite core		N/A
G.5.3.4.5	Thermal cycling test and compliance		N/A
G.5.3.4.6	Partial discharge test		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G.5.3.4.7	Routine test		N/A
G.5.4	Motors		N/A
G.5.4.1	General requirements		N/A
G.5.4.2	Motor overload test conditions		N/A
G.5.4.3	Running overload test		N/A
G.5.4.4.2	Locked-rotor overload test		N/A
	Test duration (days) :		—
G.5.4.5	Running overload test for DC motors		N/A
G.5.4.5.2	Tested in the unit		N/A
G.5.4.5.3	Alternative method		N/A
G.5.4.6	Locked-rotor overload test for DC motors		N/A
G.5.4.6.2	Tested in the unit		N/A
	Maximum Temperature :		N/A
G.5.4.6.3	Alternative method		N/A
G.5.4.7	Motors with capacitors		N/A
G.5.4.8	Three-phase motors		N/A
G.5.4.9	Series motors		N/A
	Operating voltage :		—
G.6	Wire Insulation		N/A
G.6.1	General		N/A
G.6.2	Enamelled winding wire insulation		N/A
G.7	Mains supply cords		N/A
G.7.1	General requirements		N/A
	Type :		—
G.7.2	Cross sectional area (mm ² or AWG) :		N/A
G.7.3	Cord anchorages and strain relief for non-detachable power supply cords		N/A
G.7.3.2	Cord strain relief		N/A
G.7.3.2.1	Requirements		N/A
	Strain relief test force (N) :		N/A
G.7.3.2.2	Strain relief mechanism failure		N/A
G.7.3.2.3	Cord sheath or jacket position, distance (mm) :		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G.7.3.2.4	Strain relief and cord anchorage material		N/A
G.7.4	Cord Entry		N/A
G.7.5	Non-detachable cord bend protection		N/A
G.7.5.1	Requirements		N/A
G.7.5.2	Test method and compliance		N/A
	Overall diameter or minor overall dimension, D (mm)..... :		—
	Radius of curvature after test (mm) :		—
G.7.6	Supply wiring space		N/A
G.7.6.1	General requirements		N/A
G.7.6.2	Stranded wire		N/A
G.7.6.2.1	Requirements		N/A
G.7.6.2.2	Test with 8 mm strand		N/A
G.8	Varistors		N/A
G.8.1	General requirements		N/A
G.8.2	Safeguards against fire		N/A
G.8.2.1	General		N/A
G.8.2.2	Varistor overload test		N/A
G.8.2.3	Temporary overvoltage test		N/A
G.9	Integrated circuit (IC) current limiters		Pass
G.9.1	Requirements		Pass
	IC limiter output current (max. 5A)..... :	See "Models and Ratings" for details.	—
	Manufacturers' defined drift :	See "Models and Ratings" for details.	—
G.9.2	Test Program		Pass
G.9.3	Compliance		Pass
G.10	Resistors		N/A
G.10.1	General		N/A
G.10.2	Conditioning		N/A
G.10.3	Resistor test		N/A
G.10.4	Voltage surge test		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G.10.5	Impulse test		N/A
G.10.6	Overload test		N/A
G.11	Capacitors and RC units		N/A
G.11.1	General requirements		N/A
G.11.2	Conditioning of capacitors and RC units		N/A
G.11.3	Rules for selecting capacitors		N/A
G.12	Optocouplers		N/A
	Optocouplers comply with IEC 60747-5-5 with specifics		N/A
	Type test voltage $V_{ini,a}$:		—
	Routine test voltage, $V_{ini,b}$:		—
G.13	Printed boards		N/A
G.13.1	General requirements		N/A
G.13.2	Uncoated printed boards		N/A
G.13.3	Coated printed boards		N/A
G.13.4	Insulation between conductors on the same inner surface		N/A
G.13.5	Insulation between conductors on different surfaces		N/A
	Distance through insulation :		N/A
	Number of insulation layers (pcs) :		—
G.13.6	Tests on coated printed boards		N/A
G.13.6.1	Sample preparation and preliminary inspection		N/A
G.13.6.2	Test method and compliance		N/A
G.14	Coating on components terminals		N/A
G.14.1	Requirements :		N/A
G.15	Pressurized liquid filled components		N/A
G.15.1	Requirements		N/A
G.15.2	Test methods and compliance		N/A
G.15.2.1	Hydrostatic pressure test		N/A
G.15.2.2	Creep resistance test		N/A
G.15.2.3	Tubing and fittings compatibility test		N/A
G.15.2.4	Vibration test		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
G.15.2.5	Thermal cycling test		N/A
G.15.2.6	Force test		N/A
G.15.3	Compliance		N/A
G.16	IC including capacitor discharge function (ICX)		N/A
G.16.1	Condition for fault tested is not required		N/A
	ICX with associated circuitry tested in equipment		N/A
	ICX tested separately		N/A
G.16.2	Tests		N/A
	Smallest capacitance and smallest resistance specified by ICX manufacturer for impulse test..... :		—
	Mains voltage that impulses to be superimposed on :		—
	Largest capacitance and smallest resistance for ICX tested by itself for 10000 cycles test..... :		—
G.16.3	Capacitor discharge test :		N/A
H	CRITERIA FOR TELEPHONE RINGING SIGNALS		N/A
H.1	General		N/A
H.2	Method A		N/A
H.3	Method B		N/A
H.3.1	Ringing signal		N/A
H.3.1.1	Frequency (Hz) :		—
H.3.1.2	Voltage (V) :		—
H.3.1.3	Cadence; time (s) and voltage (V) :		—
H.3.1.4	Single fault current (mA): :		—
H.3.2	Tripping device and monitoring voltage		N/A
H.3.2.1	Conditions for use of a tripping device or a monitoring voltage		N/A
H.3.2.2	Tripping device		N/A
H.3.2.3	Monitoring voltage (V)..... :		N/A
J	INSULATED WINDING WIRES FOR USE WITHOUT INTERLEAVED INSULATION		N/A
J.1	General		N/A
	Winding wire insulation :		—
	Solid round winding wire, diameter (mm) :		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Solid square and rectangular (flatwise bending) winding wire, cross-sectional area (mm ²)		N/A
J.2/J.3	Tests and Manufacturing		—
K	SAFETY INTERLOCKS		N/A
K.1	General requirements		N/A
	Instructional safeguard		N/A
K.2	Components of safety interlock safeguard mechanism		N/A
K.3	Inadvertent change of operating mode		N/A
K.4	Interlock safeguard override		N/A
K.5	Fail-safe		N/A
K.5.1	Under single fault condition		N/A
K.6	Mechanically operated safety interlocks		N/A
K.6.1	Endurance requirement		N/A
K.6.2	Test method and compliance		N/A
K.7	Interlock circuit isolation		N/A
K.7.1	Separation distance for contact gaps & interlock circuit elements		N/A
	In circuit connected to mains, separation distance for contact gaps (mm)		N/A
	In circuit isolated from mains, separation distance for contact gaps (mm)		N/A
	Electric strength test before and after the test of K.7.2.....		N/A
K.7.2	Overload test, Current (A).....		N/A
K.7.3	Endurance test		N/A
K.7.4	Electric strength test		N/A
L	DISCONNECT DEVICES		N/A
L.1	General requirements		N/A
L.2	Permanently connected equipment		N/A
L.3	Parts that remain energized		N/A
L.4	Single-phase equipment		N/A
L.5	Three-phase equipment		N/A
L.6	Switches as disconnect devices		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
L.7	Plugs as disconnect devices		N/A
L.8	Multiple power sources		N/A
	Instructional safeguard :		N/A
M	EQUIPMENT CONTAINING BATTERIES AND THEIR PROTECTION CIRCUITS		N/A
M.1	General requirements		N/A
M.2	Safety of batteries and their cells		N/A
M.2.1	Batteries and their cells comply with relevant IEC standards :		N/A
M.3	Protection circuits for batteries provided within the equipment		N/A
M.3.1	Requirements		N/A
M.3.2	Test method		N/A
	Overcharging of a rechargeable battery		N/A
	Excessive discharging		N/A
	Unintentional charging of a non-rechargeable battery		N/A
	Reverse charging of a rechargeable battery		N/A
M.3.3	Compliance		N/A
M.4	Additional safeguards for equipment containing a portable secondary lithium battery		N/A
M.4.1	General		N/A
M.4.2	Charging safeguards		N/A
M.4.2.1	Requirements		N/A
M.4.2.2	Compliance :		N/A
M.4.3	Fire enclosure :		N/A
M.4.4	Drop test of equipment containing a secondary lithium battery		N/A
M.4.4.2	Preparation and procedure for the drop test		N/A
M.4.4.3	Drop, Voltage on reference and dropped batteries (V); voltage difference during 24 h period (%): :		N/A
M.4.4.4	Check of the charge/discharge function		N/A
M.4.4.5	Charge / discharge cycle test		N/A
M.4.4.6	Compliance		N/A
M.5	Risk of burn due to short-circuit during carrying		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
M.5.1	Requirement		N/A
M.5.2	Test method and compliance		N/A
M.6	Safeguards against short-circuits		N/A
M.6.1	External and internal faults		N/A
M.6.2	Compliance		N/A
M.7	Risk of explosion from lead acid and NiCd batteries		N/A
M.7.1	Ventilation preventing explosive gas concentration		N/A
	Calculated hydrogen generation rate :		N/A
M.7.2	Test method and compliance		N/A
	Minimum air flow rate, Q (m ³ /h) :		N/A
M.7.3	Ventilation tests		N/A
M.7.3.1	General		N/A
M.7.3.2	Ventilation test – alternative 1		N/A
	Hydrogen gas concentration (%) :		N/A
M.7.3.3	Ventilation test – alternative 2		N/A
	Obtained hydrogen generation rate :		N/A
M.7.3.4	Ventilation test – alternative 3		N/A
	Hydrogen gas concentration (%) :		N/A
M.7.4	Marking :		N/A
M.8	Protection against internal ignition from external spark sources of batteries with aqueous electrolyte		N/A
M.8.1	General		N/A
M.8.2	Test method		N/A
M.8.2.1	General		N/A
M.8.2.2	Estimation of hypothetical volume V_z (m ³ /s)..... :		—
M.8.2.3	Correction factors :		—
M.8.2.4	Calculation of distance d (mm) :		—
M.9	Preventing electrolyte spillage		N/A
M.9.1	Protection from electrolyte spillage		N/A
M.9.2	Tray for preventing electrolyte spillage		N/A
M.10	Instructions to prevent reasonably foreseeable misuse		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Instructional safeguard		N/A
N	ELECTROCHEMICAL POTENTIALS		N/A
	Material(s) used		—
O	MEASUREMENT OF CREEPAGE DISTANCES AND CLEARANCES		N/A
	Value of X (mm)		—
P	SAFEGUARDS AGAINST CONDUCTIVE OBJECTS		N/A
P.1	General		N/A
P.2	Safeguards against entry or consequences of entry of a foreign object		N/A
P.2.1	General		N/A
P.2.2	Safeguards against entry of a foreign object		N/A
	Location and Dimensions (mm)		—
P.2.3	Safeguards against the consequences of entry of a foreign object		N/A
P.2.3.1	Safeguard requirements		N/A
	The ES3 and PS3 keep-out volume in Figure P.3 not applicable to transportable equipment		N/A
	Transportable equipment with metalized plastic parts		N/A
P.2.3.2	Consequence of entry test		N/A
P.3	Safeguards against spillage of internal liquids		N/A
P.3.1	General		N/A
P.3.2	Determination of spillage consequences		N/A
P.3.3	Spillage safeguards		N/A
P.3.4	Compliance		N/A
P.4	Metallized coatings and adhesives securing parts		N/A
P.4.1	General		N/A
P.4.2	Tests		N/A
	Conditioning, T _c (°C)		—
	Duration (weeks)		—
Q	CIRCUITS INTENDED FOR INTERCONNECTION WITH BUILDING WIRING		N/A
Q.1	Limited power sources		N/A
Q.1.1	Requirements		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	a) Inherently limited output		N/A
	b) Impedance limited output		N/A
	c) Regulating network limited output		N/A
	d) Overcurrent protective device limited output		N/A
	e) IC current limiter complying with G.9		N/A
Q.1.2	Test method and compliance		N/A
	Current rating of overcurrent protective device (A)		N/A
Q.2	Test for external circuits – paired conductor cable		N/A
	Maximum output current (A)		N/A
	Current limiting method.....		—
R	LIMITED SHORT CIRCUIT TEST		N/A
R.1	General		N/A
R.2	Test setup		N/A
	Overcurrent protective device for test.....		—
R.3	Test method		N/A
	Cord/cable used for test.....		—
R.4	Compliance		N/A
S	TESTS FOR RESISTANCE TO HEAT AND FIRE		N/A
S.1	Flammability test for fire enclosures and fire barrier materials of equipment where the steady state power does not exceed 4 000 W		N/A
	Samples, material		—
	Wall thickness (mm)		—
	Conditioning (°C)		—
	Test flame according to IEC 60695-11-5 with conditions as set out		N/A
	- Material not consumed completely		N/A
	- Material extinguishes within 30s		N/A
	- No burning of layer or wrapping tissue		N/A
S.2	Flammability test for fire enclosure and fire barrier integrity		N/A
	Samples, material		—

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Clause	Requirement + Test	Result - Remark	Verdict
	Wall thickness (mm)		—
	Conditioning (°C)		—
S.3	Flammability test for the bottom of a fire enclosure		N/A
S.3.1	Mounting of samples		N/A
S.3.2	Test method and compliance		N/A
	Mounting of samples		—
	Wall thickness (mm)		—
S.4	Flammability classification of materials		N/A
S.5	Flammability test for fire enclosure materials of equipment with a steady state power exceeding 4 000 W		N/A
	Samples, material		—
	Wall thickness (mm)		—
	Conditioning (°C)		—
T	MECHANICAL STRENGTH TESTS		N/A
T.1	General		N/A
T.2	Steady force test, 10 N		N/A
T.3	Steady force test, 30 N		N/A
T.4	Steady force test, 100 N		N/A
T.5	Steady force test, 250 N		N/A
T.6	Enclosure impact test		N/A
	Fall test		N/A
	Swing test		N/A
T.7	Drop test		N/A
T.8	Stress relief test.....		N/A
T.9	Glass Impact Test		N/A
T.10	Glass fragmentation test		N/A
	Number of particles counted.....		N/A
T.11	Test for telescoping or rod antennas		N/A
	Torque value (Nm)		N/A
U	MECHANICAL STRENGTH OF CATHODE RAY TUBES (CRT) AND PROTECTION AGAINST THE EFFECTS OF IMPLOSION		N/A
U.1	General		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Instructional safeguard		N/A
U.2	Test method and compliance for non-intrinsically protected CRTs		N/A
U.3	Protective screen		N/A
V	DETERMINATION OF ACCESSIBLE PARTS		N/A
V.1	Accessible parts of equipment		N/A
V.1.1	General		N/A
V.1.2	Surfaces and openings tested with jointed test probes		N/A
V.1.3	Openings tested with straight unjointed test probes		N/A
V.1.4	Plugs, jacks, connectors tested with blunt probe		N/A
V.1.5	Slot openings tested with wedge probe		N/A
V.1.6	Terminals tested with rigid test wire		N/A
V.2	Accessible part criterion		N/A
X	ALTERNATIVE METHOD FOR DETERMINING CLEARANCES FOR INSULATION IN CIRCUITS CONNECTED TO AN AC MAINS NOT EXCEEDING 420 V PEAK (300 V RMS)		N/A
	Clearance		N/A
Y	CONSTRUCTION REQUIREMENTS FOR OUTDOOR ENCLOSURES		N/A
Y.1	General		N/A
Y.2	Resistance to UV radiation		N/A
Y.3	Resistance to corrosion		N/A
Y.3.1	Metallic parts of outdoor enclosures are resistant to effects of water-borne contaminants by..... :		N/A
Y.3.2	Test apparatus		N/A
Y.3.3	Water – saturated sulphur dioxide atmosphere		N/A
Y.3.4	Test procedure		N/A
Y.3.5	Compliance		N/A
Y.4	Gaskets		N/A
Y.4.1	General		N/A
Y.4.2	Gasket tests		N/A
Y.4.3	Tensile strength and elongation tests		N/A
	Alternative test methods		N/A
Y.4.4	Compression test		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
Y.4.5	Oil resistance		N/A
Y.4.6	Securing means		N/A
Y.5	Protection of equipment within an outdoor enclosure		N/A
Y.5.1	General		N/A
Y.5.2	Protection from moisture		N/A
	Relevant tests of IEC 60529 or Y.5.3 :		N/A
Y.5.3	Water spray test		N/A
Y.5.4	Protection from plants and vermin		N/A
Y.5.5	Protection from excessive dust		N/A
Y.5.5.1	General		N/A
Y.5.5.2	IP5X equipment		N/A
Y.5.5.3	IP6X equipment		N/A
Y.6	Mechanical strength of enclosures		N/A
Y.6.1	General		N/A
Y.6.2	Impact test :		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

5.2	TABLE: Classification of electrical energy sources						N/A
Supply Voltage	Location (e.g. circuit designation)	Test conditions	Parameters				ES Class
			U (V)	I (mA)	Type ¹⁾	Additional Info ²⁾	
Supplementary information:							
--							

5.4.1.8	TABLE: Working voltage measurement					N/A
Location		RMS voltage (V)	Peak voltage (V)	Frequency (Hz)	Comments	
Supplementary information:						
--						

5.4.1.10.2	TABLE: Vicat softening temperature of thermoplastics				N/A
Method:			ISO 306 / B50		—
Object/ Part No./Material	Manufacturer/trademark		Thickness (mm)	T softening (°C)	
Supplementary information:					
--					

5.4.1.10.3	TABLE: Ball pressure test of thermoplastics					N/A
Allowed impression diameter (mm) :				≤ 2 mm		—
Object/Part No./Material	Manufacturer/trademark	Thickness (mm)	Test temperature (°C)		Impression diameter (mm)	
Supplementary information:						
--						

5.4.2, 5.4.3	TABLE: Minimum Clearances/Creepage distance							N/A
Clearance (cl) and creepage distance (cr) at/of/between:	Up (V)	U _{rms} (V)	Freq ¹⁾ (kHz)	Required cl (mm)	cl (mm)	E.S. ²⁾ (V)	Required cr (mm)	cr (mm)
Supplementary information:								

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Clause	Requirement + Test	Result - Remark	Verdict

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5.4.4.2	TABLE: Minimum distance through insulation				N/A
Distance through insulation (DTI) at/of:	Peak voltage (V)	Insulation	Required DTI (mm)	Measured DTI (mm)	
Supplementary information:					
--					

5.4.4.9	TABLE: Solid insulation at frequencies >30 kHz					N/A
Insulation material	E_P	Frequency (kHz)	K_R	Thickness d (mm)	Insulation	V_{PW} (Vpk)
Supplementary information:						
--						

5.4.9	TABLE: Electric strength tests				N/A
Test voltage applied between:		Voltage shape (Surge, Impulse, AC, DC, etc.)	Test voltage (V)	Breakdown Yes / No	
Supplementary information:					
--					

5.5.2.2	TABLE: Stored discharge on capacitors					N/A
Location	Supply Voltage (V)	Operating and fault condition ¹⁾	Switch position	Measured voltage (Vpk)	ES Class	
Supplementary information:						
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5.6.6	TABLE: Resistance of protective conductors and terminations				N/A
Location		Test current (A)	Duration (min)	Voltage drop (V)	Resistance (Ω)
Supplementary information:					
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Clause	Requirement + Test	Result - Remark	Verdict

5.7.4	TABLE: Unearthed accessible parts					N/A
Location	Operating and fault conditions	Supply Voltage (V)	Parameters			ES class
			Voltage (V _{rms} or V _{pk})	Current (A _{rms} or A _{pk})	Freq. (Hz)	
Supplementary information:						
--						

5.7.5	TABLE: Earthed accessible conductive part				N/A
Supply voltage (V):					—
Phase(s):		[] Single Phase; [] Three Phase; [] Delta; [] Wye			
Power Distribution System:		[] TN []TT [] IT			
Location		Fault Condition No in IEC 60990 clause 6.2.2	Touch current (mA)	Comment	
Supplementary Information:					
--					

5.8	TABLE: Backfeed safeguard in battery backed up supplies					N/A
Location	Supply voltage (V)	Operating and fault condition	Time (s)	Open-circuit voltage (V)	Touch current (A)	ES Class
Supplementary information:						
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6.2.2	TABLE: Power source circuit classifications					N/A
Location	Operating and fault condition	Voltage (V)	Current (A)	Max. Power ¹⁾ (W)	Time (S)	PS class
Supplementary information:						
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6.2.3.1	TABLE: Determination of Arcing PIS				N/A
Location		Open circuit voltage after 3 s (V _{pk})	Measured r.m.s current (A)	Calculated value	Arcing PIS? Yes / No

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict

Supplementary information:
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6.2.3.2	Table: Determination of Resistive PIS			N/A
Location	Operating and fault condition	Dissipate power (W)	Resistive PIS? Yes/No	
Supplementary Information:				
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8.5.5	TABLE: High Pressure Lamp				N/A
Lamp manufacturer	Lamp type	Explosion method	Longest axis of glass particle (mm)	Particle found beyond 1 m Yes / No?	
Supplementary information:					
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9.6	TABLE: Temperature measurements for wireless power transmitters							N/A
Supply voltage (V)								—
Max. transmit power of transmitter (W)								—
Foreign objects	w/o receiver and direct contact		with receiver and direct contact		with receiver and at distance of 2 mm		with receiver and at distance of 5 mm	
	Object (°C)	Ambient (°C)	Object (°C)	Ambient (°C)	Object (°C)	Ambient (°C)	Object (°C)	Ambient (°C)
Supplementary information:								
--								

5.4.1.4, 9.3, B.1.5, B.2.6	TABLE: Temperature measurements					Pass
Supply voltage (V)		2.7Vdc/5.5Vdc	2.7Vdc/5.5Vdc			—
Ambient temperature during test T_{amb} (°C)		25	85			—

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Clause	Requirement + Test			Result - Remark			Verdict
Maximum measured temperature T of part/at:		T (°C)				Allowed T _{max} (°C)	
Model AP2182AMPG		38.0	90.1	-	-	130	
Model AP2182AMPG		32.2	93.7	-	-	130	
Temperature T of winding:	t ₁ (°C)	R ₁ (Ω)	t ₂ (°C)	R ₂ (Ω)	T (°C)	Allowed T _{max} (°C)	Insulation class
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
Supplementary information:							
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B.2.5		TABLE: Input test						N/A
U (V)	Hz	I (A)	I rated (A)	P (W)	P rated (W)	Fuse No	I fuse (A)	Condition/status
Supplementary information:								
--								

B.3, B.4		TABLE: Abnormal operating and fault condition tests					Pass
Ambient temperature T _{amb} (°C)						25C	—
Power source for EUT: Manufacturer, model/type, output rating ..						-	—
Component No.	Condition	Supply voltage (V)	Test time	Fuse no.	Fuse current (A)	Observation	
Model AP2152A (Current Limit:1.5A)	Overload	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.	
Model AP2192A (Current Limit:4.5A)	Overload	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.	

IEC 62368-1						
Clause	Requirement + Test			Result - Remark		Verdict
Model AP2152A (Current Limit:1.5A)	Tamb = 25°C Enable pin – Cycle: Power On with Loaded To Maximum Rated Load, Enable Pin Off to On	2.7 – 5.5Vdc	10,000 cycles	N/A	N/A	10,000 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = 25°C Enable pin – Cycle: Power On with Loaded To Maximum Rated Load, Enable Pin Off to On	2.7 – 5.5Vdc	10,000 cycles	N/A	N/A	10,000 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2152A (Current Limit:1.5A)	Tamb = 85°C Enable pin – Cycle: Power On with Output Short-Circuited, Enable Pin Off to On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = 85°C Enable pin – Cycle: Power On with Output Short-Circuited, Enable Pin Off to On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2152A (Current Limit:1.5A)	Tamb = -40°C Enable pin – Cycle: Power On with Output Short-Circuited, Enable Pin Of	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = -40°C Enable pin – Cycle: Power On with Output Short-Circuited, Enable Pin Of	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.

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Clause	Requirement + Test			Result - Remark		Verdict
Model AP2152A (Current Limit:1.5A)	Tamb = 85°C Input Power pin – Cycle: Output Short-Circuit, Power to Circuit Off to Power On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = 85°C Input Power pin – Cycle: Output Short-Circuit, Power to Circuit Off to Power On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2152A (Current Limit:1.5A)	Tamb = -40°C Input Power pin – Cycle: Output Short-Circuit, Power to Circuit Off to Power On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = -40°C Input Power pin – Cycle: Output Short-Circuit, Power to Circuit Off to Power On	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2152A (Current Limit:1.5A)	Tamb = 85°C Input power pin – cycle: Power On with Output Open Circuit to Short	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2192A (Current Limit:4.5A)	Tamb = 85°C Input power pin – cycle: Power On with Output Open Circuit to Short	2.7 – 5.5Vdc	50 cycles	N/A	N/A	50 cycles completed. There was no fire or shock hazard for all outputs tested.
Model AP2152A (Current Limit:1.5A)	Output Short Circuit to Ground	6.05Vdc	7 Days	N/A	N/A	The current did not display any significant change after 7 days of operation and the device was capable of performing its intended function.
Model AP2192A (Current Limit:4.5A)	Output Short Circuit to Ground	6.05Vdc	7 Days	N/A	N/A	The current did not display any significant change after 7 days of operation and the device was

IEC 62368-1						
Clause	Requirement + Test			Result - Remark		Verdict
						capable of performing its intended function.
Supplementary information:						
-						

M.3	TABLE: Protection circuits for batteries provided within the equipment						N/A		
Is it possible to install the battery in a reverse polarity position? :								—	
Equipment Specification		Charging							
		Voltage (V)				Current (A)			
Manufacturer/type		Battery specification							
		Non-rechargeable batteries		Rechargeable batteries					
		Discharging current (A)	Unintentional charging current (A)	Charging		Discharging current (A)	Reverse charging current (A)		
				Voltage (V)	Current (A)				
Note: The tests of M.3.2 are applicable only when above appropriate data is not available.									
Specified battery temperature (°C) :									
Component No.	Fault condition	Charge/discharge mode	Test time	Temp. (°C)	Current (A)	Voltage (V)	Observation		
Supplementary information:									
--									

M.4.2	TABLE: Charging safeguards for equipment containing a secondary lithium battery						N/A
Maximum specified charging voltage (V) :							—
Maximum specified charging current (A) :							—
Highest specified charging temperature (°C) :							
Lowest specified charging temperature (°C) :							
Battery manufacturer/type	Operating and fault condition	Measurement			Observation		
		Charging voltage (V)	Charging current (A)	Temp. (°C)			

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict

Supplementary information:

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Q.1	TABLE: Circuits intended for interconnection with building wiring (LPS)						N/A
Output Circuit	Condition	U _{oc} (V)	Time (s)	I _{sc} (A)		S (VA)	
				Meas.	Limit	Meas.	Limit
Supplementary Information:							
--							

T.2, T.3, T.4, T.5	TABLE: Steady force test						N/A
Location/Part	Material	Thickness (mm)	Probe	Force (N)	Test Duration (s)	Observation	
Supplementary information:							
--							

T.6, T.9	TABLE: Impact test					N/A
Location/Part	Material	Thickness (mm)	Height (mm)	Observation		
Supplementary information:						
--						

T.7	TABLE: Drop test					N/A
Location/Part		Material	Thickness (mm)	Height (mm)	Observation	
Supplementary information:						
--						

T.8	TABLE: Stress relief test					N/A
Location/Part	Material	Thickness (mm)	Oven Temperature (°C)	Duration (h)	Observation	

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict

Supplementary information:
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X	TABLE: Alternative method for determining minimum clearances distances			N/A
Clearance distanced between:	Peak of working voltage (V)	Required cl (mm)	Measured cl (mm)	
Supplementary information:				

IEC 62368-1			
Clause	Requirement + Test	Result - Remark	Verdict

4.1.2	TABLE: Critical components information					Pass
Object / part No.	Manufacturer/ trademark	Type / model	Technical data	Standard	Mark(s) of conformity ¹⁾	
Housing/Molded Compound	Interchangeable	Interchangeable	130 degree C	UL 746C (6th)+	- , UL, N/A	
+ Indicates UL standard has requirements that meet or exceed the relevant requirements in IEC standard Column.	--	--	--	--	-- , --	
Supplementary information:						
1) Provided evidence ensures the agreed level of compliance. See OD-CB2039.						

Enclosure
National Differences
USA / Canada

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict

ATTACHMENT TO TEST REPORT IEC 62368-1 U.S.A. AND CANADA NATIONAL DIFFERENCES (Audio/video, information and communication technology equipment – Part 1: Safety requirements)	
Differences according to.....:	CSA/UL 62368-1:2019
TRF template used.....:	IECEE OD-2020-F3, Ed. 1.1
Attachment Form No.....:	US_CA_ND_IEC62368_1E
Attachment Originator.....:	UL(US)
Master Attachment.....:	Dated 2022-03-04
Copyright © 2022 IEC System for Conformity Testing and Certification of Electrical Equipment (IECEE), Geneva, Switzerland. All rights reserved.	

IEC 62368-1 - US and Canadian National Differences Special National Conditions based on Regulations and Other National Differences			
1 (1DV.1) (1.3)	All equipment is to be designed to allow installation in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, the Canadian Electrical Code (CEC), Part 1, CAN/CSA C22.1, and when applicable, the National Electrical Safety Code, IEEE C2. Also, for such equipment marked or otherwise identified, installation is allowed per the Standard for the Protection of Information Technology Equipment, ANSI/NFPA 75.		N/A
1 (1DV.2.1)	This standard includes additional requirements for equipment used for entertainment purposes intended for installation in general patient care areas of health care facilities. See Annex DVB.		N/A
1 (1DV.2.2)	This standard includes additional requirements for equipment intended for mounting under cabinets. See Annex DVC.		N/A
1 (1DV.2.3)	IEC 62368-3 clause 5 for DC power transfer at ES1 or ES2 voltage levels is considered informative. IEC 62368-3 clause 6 for remote power feeding telecommunication (RFT) circuits is considered normative (see ITU K.50). Alternatively, equipment with RFT circuits are given in either UL 2391 or CSA/UL 60950-21. RFT-C circuits are not permitted unless the RFT-C circuit complies with RFT-V limits ($\leq 200V$ per conductor to earth).		N/A
1 (1DV.3)	For protection against direct lightning strikes, reference is made to NFPA 780 and CAN/CSA-B72 for additional requirements.		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
1 (1DV.5)	Additional requirements apply to some forms of power distribution equipment, including sub-assemblies.		N/A
4.1 (4.1.17)	For lengths exceeding 3.05 m, external interconnecting cable assemblies are required to be a suitable cable type (e.g., DP, CL2) specified in the NEC.		N/A
	For lengths 3.05 m or less, external interconnecting cable assemblies that are not types specified in the NEC generally are required to have special construction features and identification markings.		N/A
4.6 (4.6.2)	Wire-wrap terminals have special construction and performance requirements.		N/A
4.8 (4.8.3, 4.8.4.5, 4.8.5)	Coin / button cell batteries have modified special construction and performance requirements.		N/A
5.4.2.3.2 (5.4.2.3.2.1)	Surge Arrestors and Transient Voltage Surge Suppressors installed external to the equipment are required to comply with the appropriate NEC and CEC requirements.		N/A
5.5.9	Receptacles, rated 125-V, single phase, 15- or 20-A accessible to either ordinary, instructed, or skilled persons are required to be provided with GFCI Protection for Personnel if the equipment containing the receptacles is installed outdoors. The protection devices are required to comply with UL 943, and CAN/CSA C22.2 No.144.		N/A
5.6.3	Protective earthing conductors comply with the minimum conductor sizes in Table G.7, except as required by Table G.7ADV.1 for cord connected equipment, or Annex DVH for permanently connected equipment.		N/A
5.7.8 (5.7.8.1)	Equipment intended to receive telecommunication ringing signals is required to comply with a special touch current measurement tests.		N/A
6.5.1	PS3 wiring outside a fire enclosure is required to comply with single fault testing in B.4, or be current limited per one of the permitted methods.		N/A
Annex F (F.3.3.9)	Output terminals provided for supply of other equipment, except mains supply, are required to be marked with a maximum rating or reference to equipment permitted to be connected.		N/A
Annex F (F.3.7)	Outdoor Enclosures are required to be classified and marked in accordance with UL 50 or 50E, or CAN/CSA C22.2 No. 94.1 or 94.2.		N/A
Annex G (G.7)	Permanent connection of equipment to the mains supply by a power supply cord is not permitted, except for certain equipment, such as ATMs.		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
	Power supply cords are required to have attachment plugs rated not less than 125 percent of the rated current of the equipment.		N/A
	Flexible power supply cords are required to be compatible with Article 400 of the NEC, and Tables 11 and 12 of the CEC.		N/A
	Minimum cord length is required to be 1.5 m, with certain constructions such as external power supplies allowed to consider both input and output cord lengths into the requirement. Power supply cords are required to be no longer than 4.5 m in length if used in ITE Rooms.		N/A
	Power supply cords for outdoor equipment are required to be suitable outdoor use type as required by Section 400.4 of the NEC and Rule 4-012 of the CEC, i.e., marked "W."		N/A
Annex H.2	Continuous ringing signals under normal operating conditions up to 16 mA only are permitted if the equipment is subjected to special installation and performance restrictions.		N/A
Annex H.4	For circuits with other than ringing signals and with voltages exceeding 42.4 V _{peak} or 60 V _{d.c.} , the maximum acceptable current through a 2000 ohm resistor (or greater) connected across the voltage source with other loads disconnected is 7.1 mA peak or 30 mA d.c. under normal operating conditions.		N/A
Annex Q (Q.3)	Equipment with paired conductor and/or coax communications cables/wiring connected to building wiring are required to have special voltage, current, power and marking requirements.		N/A
Annex DVA (1)	Equipment that is designed such that it may be powered from a separate electrical service, is required to meet applicable requirements for service equipment for control and protection of services and their installation and complies with Article 230 of the National Electrical Code (NEC), NFPA 70 and Section 6 of the Canadian Electrical Code, Part I, CSA C22.1.		N/A
	Equipment intended for use in spaces used for environmental air (plenums) are subjected to special flammability requirements for heat and visible smoke release.		N/A
	For ITE room applications, automated information storage systems with combustible media greater than 0.76 m ³ (27 cu ft) are required to have a provision for connection of either automatic sprinklers or a gaseous agent extinguishing system with an extended discharge.		N/A
	Consumer products designed or intended primarily for children 12 years of age or younger are subject to additional requirements in accordance with U.S. and Canadian Regulations.		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
	Baby monitors are required to additionally comply with ASTM F2951, Consumer Safety Specification for Baby Monitors.		N/A
	Storage batteries and battery management equipment, other than associated with lead-acid batteries, and including battery backup systems that are not an integral part of stationary AV and ICT equipment, such as provided in separate cabinets, are required to be certified (listed) to the appropriate standard(s) for such storage batteries and equipment.		N/A
Annex DVA (5.6)	For Pluggable Equipment Type A, the protection in the installation is assumed to be 20A.		N/A
Annex DVA (6.3)	The maximum quantity of flammable liquid stored in equipment is required to comply with NFPA 30.		N/A
Annex DVA (6.4.8)	For ITE room applications, enclosures with combustible material measuring greater than 0.9 m ² (10 sq ft) or a single dimension greater than 1.8 m (6 ft) are required to have a flame spread rating of 50 or less. For equipment with the same dimensions for other applications, an external surface that is not a fire enclosure requires a minimum flammability classification of V-1.		N/A
Annex DVA (10.3)	Equipment with lasers is required to meet the U.S. Code of Federal Regulations 21 CFR 1040 (and the Canadian Radiation Emitting Devices Act, REDR C1370).		N/A
Annex DVA (10.5)	Equipment that produces ionizing radiation is required to comply with the U.S. Code of Federal Regulations, 21 CFR 1020 (and the Canadian Radiation Emitting Devices Act, REDR C1370).		N/A
Annex DVA (F.3.3.4)	Equipment for use on a.c. mains supply systems with a neutral and more than one phase conductor (e.g. 120/240 V, 3-wire) require a special marking format for electrical ratings. Additional considerations apply for voltage ratings that exceed the attachment cap rating or that are lower than the "Normal Operating Condition" in Table 2 of CAN/CSA C22.2 No. 235."		N/A
Annex DVA (F.3.3.6)	Equipment identified for ITE (computer) room installation is required to be marked with the rated current.		N/A
Annex DVA (G.1)	Vertically-mounted disconnect switches and circuit breakers are required to have the "on" position indicated by the handle in the up position, where mounted in an enclosure, vertically mounted disconnect switches and circuit breakers with vertical operating means extending outside the enclosure are required to indicate in a location visible when accessing the external operating means whether the switch or circuit breaker is in the open (off) or closed (on) position.		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
Annex DVA (G.3.4)	Suitable NEC/CEC branch circuit protection rated at the maximum circuit rating is required for all standard supply outlets and receptacles (such as supplied in power distribution units) if the supply branch circuit protection is not suitable.		N/A
	Where a fuse is used to provide Class 2 or Class 3 current limiting, it is not operator-accessible unless it is non- interchangeable.		N/A
Annex DVA (G.4.2)	Equipment with isolated ground (earthing) receptacles is required to comply with NEC 250.146(D) and CEC 10-400 and 10-612.		N/A
Annex DVA (G.4.3)	Interconnection of units by conductors supplied by a limited power source, or a Class 2 circuit defined in the NEC/CEC may have field wiring connections other than specified in DVH.3, such as wire-wrap and crimp-on types, if the limited power source and Class 2 circuits are separated from all other circuits by barriers, routing or fixing.		N/A
Annex DVA (G.5.3)	Power distribution transformers distributing power at 100 volts or more, and rated 10 kVA or more, require special transformer overcurrent protection.		N/A
Annex DVA (G.5.4)	Motor control devices are required for cord-connected equipment with a mains-connected motor if the equipment is rated more than 12 A, or if the equipment has a nominal voltage rating greater than 120 V, or if the motor is rated more than 1/3 hp (locked rotor current over 43 A).		N/A
Annex DVA (G.7)	Flexible cords used outdoors are required to have the suffix “W” marked on the flexible cord.		N/A
Annex DVA (M)	For ITE room applications, equipment with battery systems capable of supplying 750 VA for five minutes are required to have a battery disconnect means that may be connected to the ITE room remote power-off circuit.		N/A
Annex DVA (Q)	If applicable per NEC 725.121(C), some limited power sources supplied from AV/ICT equipment are required to have a label indicating the maximum voltage and rated current output per conductor for each connection point. Where multiple connection points have the same rating, a single label is permitted to be used.		N/A
	Wiring terminals intended to supply Class 2 outputs in accordance with the NEC or CEC Part 1 are required to be marked with the voltage rating and “Class 2” or equivalent. The marking is located adjacent to the terminals and visible during wiring.		N/A
	Applicable parts of Chapter 8 of the NEC, and Rules 54 and 60 of the CEC, may be applicable to ITE installed outdoors with connections to communication systems.		N/A
Annex DVB (1)	Additional requirements apply for equipment used for entertainment purposes intended for		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
	installation in general patient care areas of health care facilities.		
Annex DVC (1)	Additional requirements apply for equipment intended for mounting under kitchen cabinets.		N/A
Annex DVE (4.1.1)	Some equipment, components, sub-assemblies and materials associated with the risk of fire, electric shock, or personal injury are required to have component or material ratings in accordance with the applicable national (U.S. and Canadian) component or material requirements. These equipment and components include: appliance couplers, attachment plugs, battery backup systems, circuit breakers, communication circuit accessories, connectors (used for current interruption of non-LPS circuits), direct plug-in equipment, electrochemical capacitor modules (energy storage modules with ultracapacitors), enclosures (outdoor), flexible cords and cables, fuses (branch circuit), ground-fault current interrupters, interconnecting cables, modular data centers, power supply cords, some power distribution equipment, printed wiring, protectors for communications circuits, receptacles, surge protective devices, vehicle battery adapters, wire connectors, and wire and cables.		N/A
Annex DVH	Equipment for permanent connection to the mains supply is subjected to additional requirements.		N/A
Annex DVH (DVH.1)	Wiring methods (terminals, leads, etc.) used for the connection of the equipment to the mains are required to be in accordance with the NEC/CEC.		N/A
Annex DVH (DVH.2.1)	For safe and reliable connection to a mains, permanently connected equipment is to be provided.		N/A
Annex DVH (DVH.2.2)	Additional considerations for D.C. mains.		N/A
Annex DVH (DVH.3.2.1)	Terminals for permanent wiring, including protective earthing terminals, are required to be suitable for U.S./Canadian wire gauge sizes, rated 125 percent of the equipment rating, and be specially marked when specified.		N/A
Annex DVH (DVH.3.2.3)	Wire binding screws are not permitted to attach conductors larger than 10 AWG (5.3 mm ²).		N/A
Annex DVH (DVH.3.2.4)	All associated mains supply terminals are located in proximity to each other and to the main protective earthing terminal, if any.		N/A
Annex DVH (DVH.3.2.5)	Terminals are located, guarded or insulated so that, should a strand of a conductor escape when the conductor is fitted, there is no likelihood of accidental contact between such a strand and accessible conductive parts or unearthed conductive parts separated from accessible conductive parts by supplementary insulation only.		N/A

IEC62368_1E – ATTACHMENT			
Clause	Requirement + Test	Result - Remark	Verdict
Annex DVH (DVH.3.3)	When field connection to an external circuit is via wires (example, free conductors), the wires are not smaller than 18 AWG (0.82 mm ²) and the free length of the wire inside an outlet box or wiring compartment is 150 mm or more.		N/A
Annex DVH (DVH.3.4)	Size of protective earthing conductors and terminals	(See sub-clause 5.6.5)	N/A
Annex DVH (DVH.4)	Permanently connected equipment is required to have a suitable wiring compartment and wire bending space.		N/A
Annex DVH (DVH.4.1)	Wire bending space		N/A
Annex DVH (DVH.4.2)	Volume of wiring compartment		N/A
Annex DVH (DVH.4.3)	Separation of circuits		N/A
Annex DVH (DVH.5)	Equipment markings and instructional safeguards		N/A
Annex DVH (DVH.5.1)	Identification of protective earthing terminal		N/A
Annex DVH (DVH.5.2)	Identification of terminal for earthed conductor (neutral)		N/A
Annex DVH (DVH.5.3)	Identification of terminals for aluminium conductors		N/A
Annex DVH (DVH.5.4)	Wire temperature ratings		N/A
Annex DVH (DVH.5.5)	Equipment connected to a centralized d.c. power system, and having one pole of the DC mains input terminal connected to the main protective earthing terminal in the equipment, is required to comply with special earthing, wiring, marking and installation instruction requirements.		N/A
Annex DVI (6.7)	Equipment intended for connection to telecommunication network outside plant cable is required to be protected against overvoltage from power line crosses.		N/A
Annex DVJ (10.6.1)	Equipment connected to a telecommunication and cable distribution networks and supplied with an earphone intended to be held against, or in the ear is required to comply with special acoustic pressure requirements.		N/A

Enclosures

Enclosures

Type	Supplement Id	Description
Photographs	03-01	Overall view of Evaluation Board
Schematics + PWB	05-01	Test Schematic
Manuals	06-01	Annex - G9
Manuals	06-02	Datasheet AP2142A and AP2142A
Manuals	06-03	Datasheet AP2162A and AP2172A
Manuals	06-04	Datasheet AP2182A and AP2192A
Miscellaneous	07-01	Draft CB Report Certificate Information
Miscellaneous	07-02	Packaging Information

Photographs ID 03-01

ORDERING INFORMATION

Device	Package Code	Output Current (A)	Enable	Packaging	EVM Part Number
AP2152ASG-13	S	0.5	High	SOP-8	AP2152ASG-EVM
AP2192ASG-13	S	1.5	High	SOP-8	AP2192ASG-EVM
AP2152AMPG-13	MP	0.5	High	MSOP8-EP	AP2152AMPG-EVM
AP2192AMPG-13	MP	1.5	High	MSOP8-EP	AP2192AMPG-EVM
AP2152AFGEG-7	FGE	0.5	High	U-DFN3030-8	AP2152AAFEGE-EVM
AP2192AFGEG-7	FGE	1.5	High	U-DFN3030-8	AP2192AAFEGE-EVM

EVALUATION BOARD



Enclosures

Photographs ID 03-01

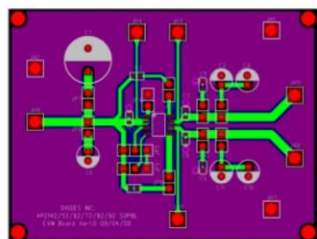
PCB LAYOUT

Figure 5 . AP21X2ASG-EVM – Top Layer

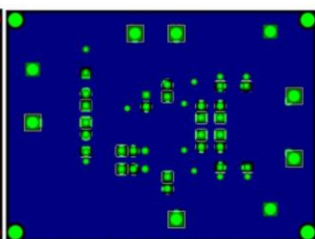


Figure 6 . AP21X2ASG-EVM – Bottom Layer

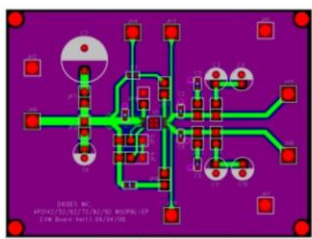


Figure 7 . AP21X2AMPG-EVM –Top Layer

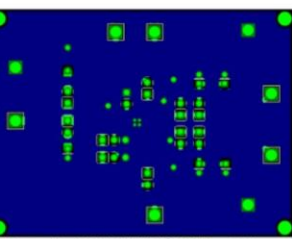


Figure 8 . AP21X2AFMG-EVM – Bottom Layer

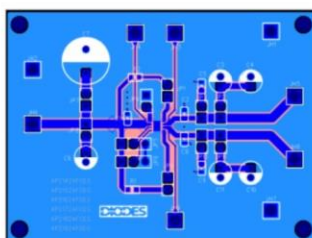


Figure 9 . AP21X2AFGEG-EVM – Top Layer

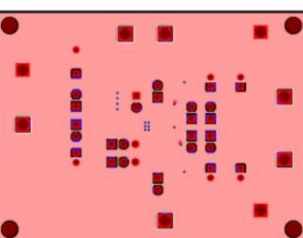


Figure 10 . AP21X2AFGEG-EVM – Bottom Layer

Enclosures

Schematics + PWB ID 05-01

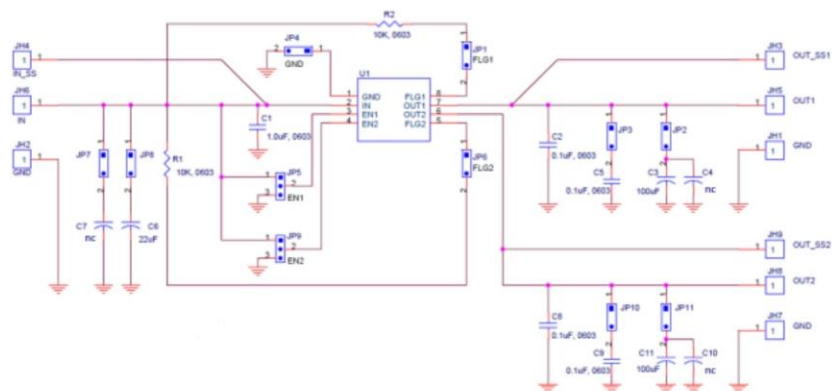
EVALUATION BOARD SCHEMATIC

Figure 4 . AP21X2ASG/MPG/AFGEG-EVM

Enclosures

Manuals ID 06-01

Annex G.9 – IC Current Limiter Testing Results	
Condition Description	Result [State Pass or Fail]
10,000 Cycles of Enable pin with the output delivering Nominal Current at 25C	Pass
50 Cycles of Enable pin with the output delivering Nominal Current at 85C	Pass
50 Cycles of Enable pin with the output delivering Nominal Current at -40C	Pass
50 Cycles of Power pin with the output delivering Nominal Current at 85C	Pass
50 Cycles of Power pin with the output delivering Nominal Current at -40C	Pass
50 Cycles of Power pin with the output delivering Short Circuit Current at 85C	Pass
50 Cycles of Enable pin with the output delivering 150% Nominal Current at 25C	Pass
50 Cycles of Power pin with the output delivering 150% Nominal Current at 25C	Pass

Enclosures

Manuals ID 06-02

**AP2142A/ AP2152A****0.5A DUAL CHANNEL CURRENT-LIMITED
POWER SWITCH WITH OUTPUT DISCHARGE****Description**

The AP2142A and AP2152A are dual channel current-limited integrated high-side power switches optimized for Universal Serial Bus (USB) and other hot-swap applications. The family of devices complies with USB standards and available with both polarities of enable input.

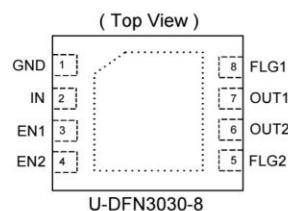
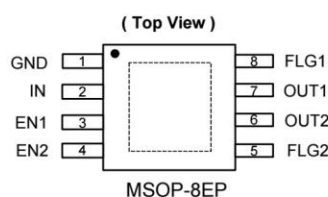
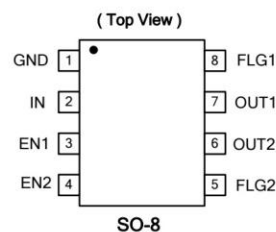
The devices have fast short-circuit response time for improved overall system robustness, and have integrated output discharge function to ensure completely controlled discharging of the output voltage capacitor. They provide a complete protection solution for application subject to heavy capacitive loads and the prospect of short circuit, and offer reverse current blocking, over-current, over-temperature and short-circuit protection, as well as controlled rise time and under-voltage lockout functionality. A 7ms deglitch capability on the open-drain flag output prevents false over-current reporting and does not require any external components.

All devices are available in SO-8, MSOP-8EP and U-DFN3030-8 packages.

Features

- Dual Channel Current-Limited Power Switch with Output Discharge
- Fast Short-Circuit Response Time: 2µs
- 0.7A Accurate Current Limiting
- Reverse Current Blocking
- 85mΩ On-Resistance
- Input Voltage Range: 2.7V – 5.5V
- Built-In Soft-Start with 0.6ms Typical Rise Time
- Short Circuit and Thermal Protection
- Fault Report (FLG) with Blanking Time (7ms typ)
- ESD protection: 2kV HBM, 300V MM
- Active High (AP2152A) or Active Low (AP2142A) Enable
- Ambient Temperature Range: -40°C to +85°C
- SO-8, MSOP-8EP and DFN3030E-8 (Exposed Pad): Available in "Green" Molding Compound (No Br, Sb)
 - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
 - **Halogen and Antimony Free. "Green" Device (Note 3)**
- UL Recognized, File Number E322375
- IEC60950-1 CB Scheme Certified

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments**Applications**

- LCD TVs & Monitors
- Set-Top-Boxes, Residential Gateways
- Laptops, Desktops, Servers,
- Printers, Docking Stations, HUBs

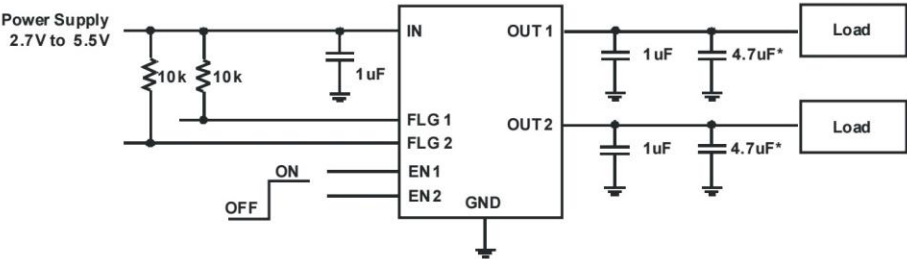
Manuals ID 06-02



AP2142A/ AP2152A

Typical Applications Circuit

AP 2152 A Enable Active High



Note: * USB 2.0 requires 120uF per hub

Available Options

Part Number	Channel	Enable Pin (EN)	Current Limit (typ)	Recommended Maximum Continuous Load Current
AP2142A	2	Active Low	0.7A	0.5A
AP2152A	2	Active High	0.7A	0.5A

Pin Descriptions

Pin Name	Pin Number		Function
	SO-8	MSOP-8EP U-DFN3030-8	
GND	1	1	Ground
IN	2	2	Voltage input pin
EN1	3	3	Switch 1 enable input, active low (AP2142A) or active high (AP2152A)
EN2	4	4	Switch 2 enable input, active low (AP2142A) or active high (AP2152A)
FLG2	5	5	Switch 2 over-current and over-temperature fault report; open-drain flag is active low when triggered
OUT2	6	6	Switch 2 voltage output pin
OUT1	7	7	Switch 1 voltage output pin
FLG1	8	8	Switch 1 over-current and over-temperature fault report; open-drain flag is active low when triggered
Exposed Pad	-	Exposed Pad	Exposed Pad: It should be connected to GND and thermal mass for enhanced thermal impedance. It should not be used as electrical ground conduction path.

Enclosures

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AP2142A/ AP2152A

Electrical Characteristics (@T_A = +25°C, V_{IN} = +5.0V, unless otherwise specified.)

Symbol	Parameter	Test Conditions (Note 5)		Min	Typ	Max	Unit
V _{UVLO}	Input UVLO			1.6	2.0	2.4	V
I _{SHDN}	Input Shutdown Current	Disabled, I _{OUT} = 0			0.1	1	μA
I _Q	Input Quiescent Current, Dual	Enabled, I _{OUT} = 0			115	180	μA
I _{LEAK}	Input Leakage Current	Disabled, OUT grounded				1	μA
I _{REV}	Reverse Leakage Current	Disabled, V _{IN} = 0V, V _{OUT} = 5V, I _{REV} at V _{IN}			0.01	0.1	μA
R _{DS(ON)}	Switch On-Resistance	V _{IN} = 5V, I _{OUT} = 0.5A, T _A = +25°C	SO-8		90	110	mΩ
			MSOP-8EP, U-DFN3030-8		85	105	
		V _{IN} = 5V, I _{OUT} = 0.5A, -40°C ≤ T _A ≤ +85°C				135	
		V _{IN} = 3.3V, I _{OUT} = 0.5A, T _A = +25°C	SO-8		110	130	
			MSOP-8EP, U-DFN3030-8		105	125	
		V _{IN} = 3.3V, I _{OUT} = 0.5A, -40°C ≤ T _A ≤ +85°C				170	
I _{LIMIT}	Over-Load Current Limit	V _{IN} = 5V, V _{OUT} = 4V, C _L = 4.7μF	-40°C ≤ T _A ≤ +85°C	0.55	0.7	0.85	A
I _{LIMIT_G}	Ganged Over-Load Current Limit	V _{IN} = 5V, V _{OUT} = 4V, OUT1 & OUT2 tied together, C _L = 4.7μF	-40°C ≤ T _A ≤ +85°C	1.1	1.4	1.7	A
I _{TRIG}	Current Limiting Trigger Threshold	Output Current Slew rate (<100A/s), C _L = 4.7μF			1.0		A
I _{TRIG_G}	Ganged Current Limiting Trigger Threshold	OUT1 & OUT2 tied together, Output Current Slew rate (<100A/s), C _L = 4.7μF			1.0		A
I _{OS}	Short-Circuit Current per Channel	OUTx connected to ground, device enabled into short circuit, C _L = 4.7μF			0.7		A
I _{OS_G}	Ganged Short-Circuit Current	OUT1 & OUT2 connected to ground, device enabled into short-circuit, C _L = 4.7μF		1.1	1.4	1.7	A
T _{SHORT}	Short-Circuit Response Time	V _{OUT} = 0V to I _{OUT} = I _{LIMIT} (output shorted to ground)			2		μs
V _{IL}	EN Input Logic Low Voltage	V _{IN} = 2.7V to 5.5V				0.8	V
V _{IH}	EN Input Logic High Voltage	V _{IN} = 2.7V to 5.5V		2			V
I _{SINK}	EN Input Leakage	V _{EN} = 0V to 5.5V				1	μA
I _{LEAK-O}	Output Leakage Current	Disabled, V _{OUT} = 0V			0.5	1	μA
T _R	Output Turn-On Rise Time	C _L = 1μF, R _{LOAD} = 10Ω			0.6	1.5	ms
T _F	Output Turn-Off Fall Time	C _L = 1μF, R _{LOAD} = 10Ω			0.05	0.3	ms
T _{D(ON)}	Output Turn-On Delay Time	C _L = 100μF, R _{LOAD} = 10Ω			0.2	0.5	ms
T _{D(OFF)}	Output Turn-Off Delay Time	C _L = 100μF, R _{LOAD} = 10Ω			0.1	0.3	ms
R _{FLG}	FLG Output FET On-Resistance	I _{FLG} = 10mA			20	40	Ω
I _{FOH}	FLG Off Current	V _{FLG} = 5V			0.01	1	μA
T _{Blank}	FLG Blanking Time	C _L = 4.7μF		4	7	15	ms
R _{DIS}	Discharge Resistance (Note 6)	V _{IN} = 5V, disabled, I _{OUT} = 1mA			100		Ω
T _{SHDN}	Thermal Shutdown Threshold	Enabled, R _{LOAD} = 1kΩ			140		°C
T _{HYS}	Thermal Shutdown Hysteresis				25		°C
θ _{JA}	Thermal Resistance Junction-to-Ambient	SO-8 (Note 7)			115		°C/W
		MSOP-8EP (Note 8)			75		
		U-DFN3030-8 (Note 8)			60		

Notes:

5. Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.

6. The discharge function is active when the device is disabled (when enable is de-asserted or during power-up / power-down when V_{IN} < V_{UVLO}). The discharge function offers a resistive discharge path for the external storage capacitor for limited time.

7. Test condition for SO-8: Device mounted on FR-4 substrate PCB with minimum recommended pad layout.

8. Test condition for MSOP-8EP and U-DFN3030-8: Device mounted on 2" x 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

Enclosures

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AP2142A/ AP2152A

Typical Performance Characteristics

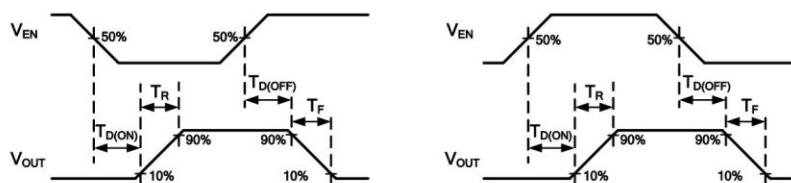


Figure 1 Voltage Waveforms: AP2142A (left), AP2152A (right)

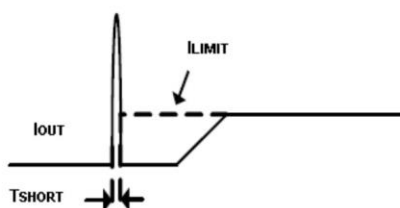
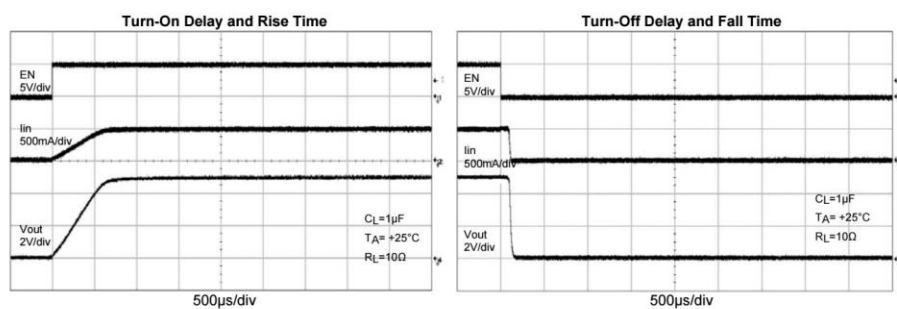


Figure 2 Response Time to Short Circuit Waveform

All Enable Plots are for AP2152A Active High



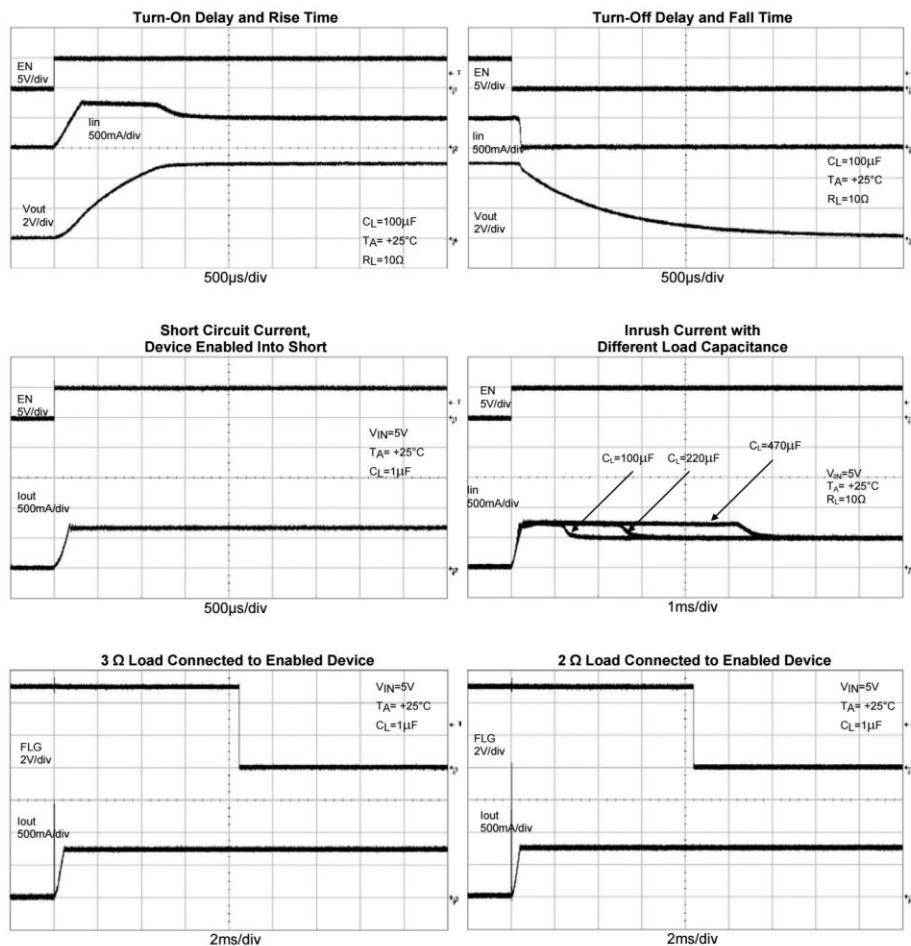
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AP2142A/ AP2152A

Typical Performance Characteristics (cont.)



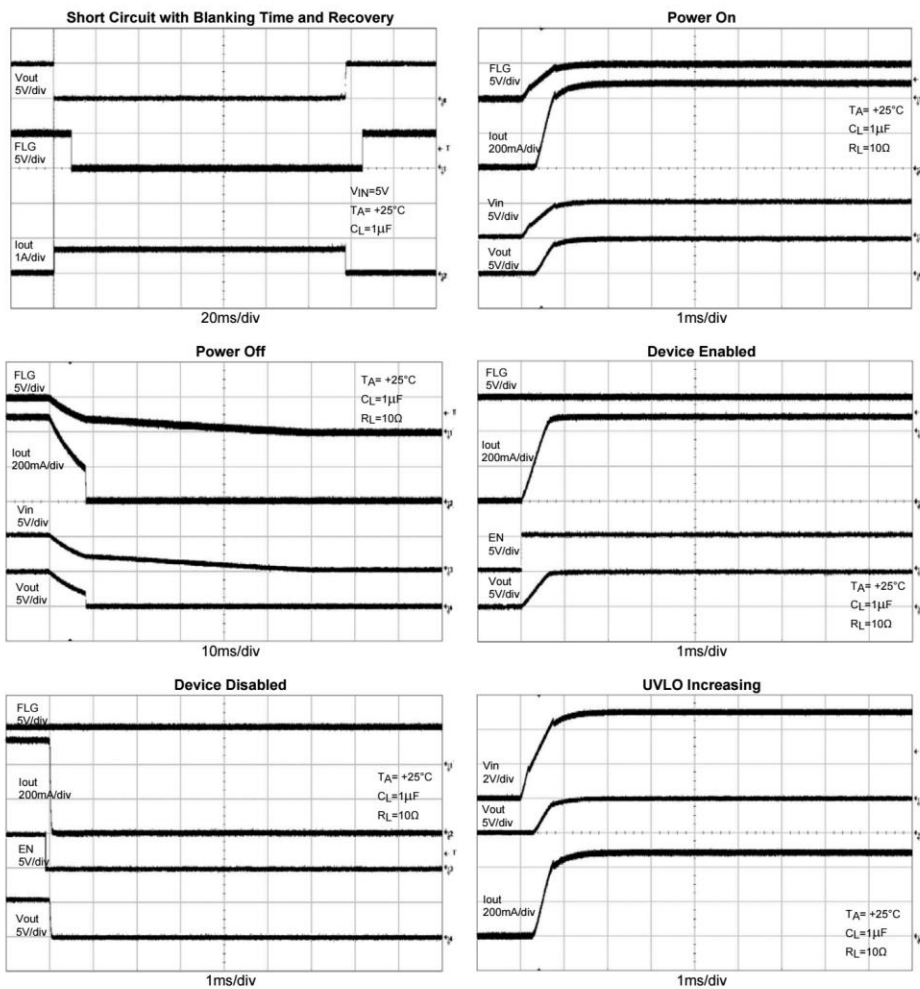
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AP2142A/ AP2152A

Typical Performance Characteristics (cont.)



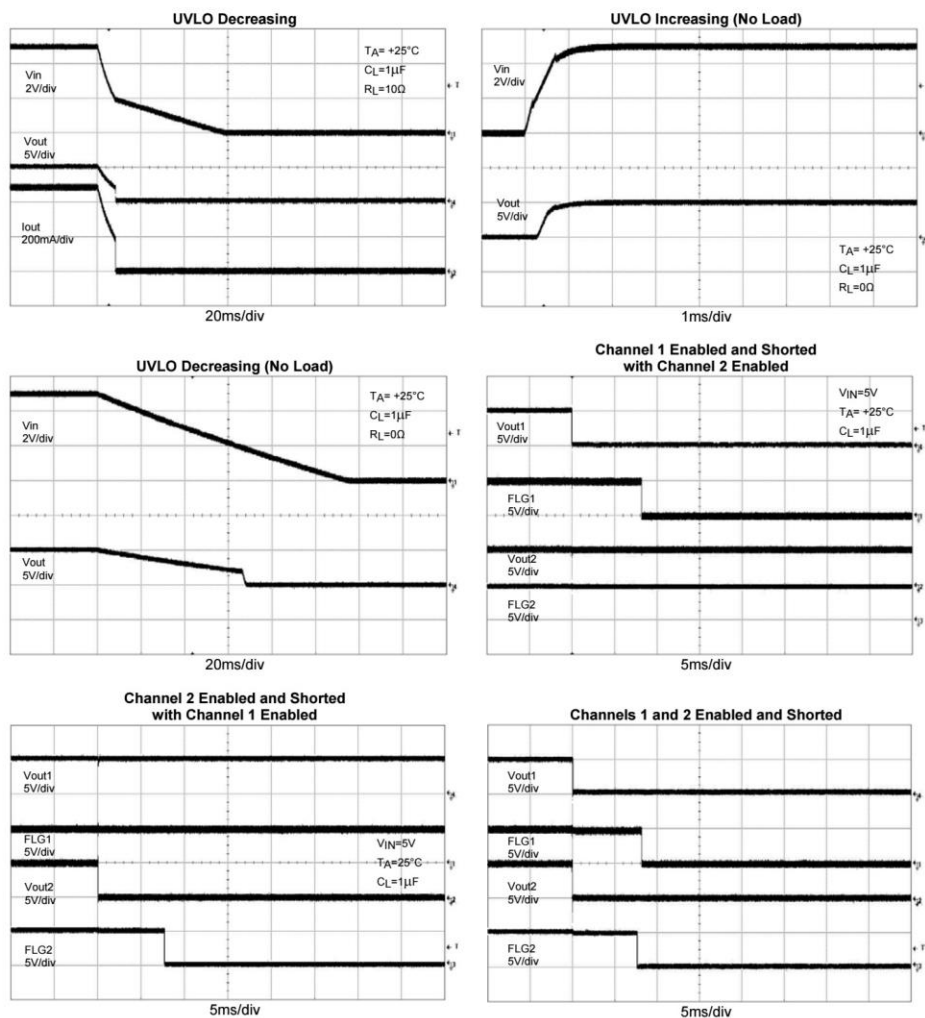
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AP2142A/ AP2152A

Typical Performance Characteristics (cont.)



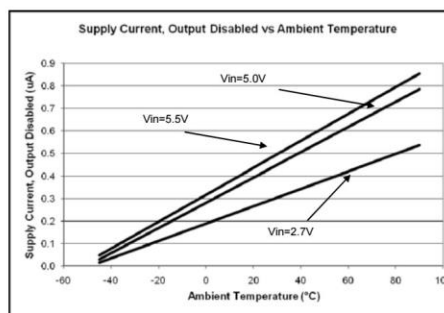
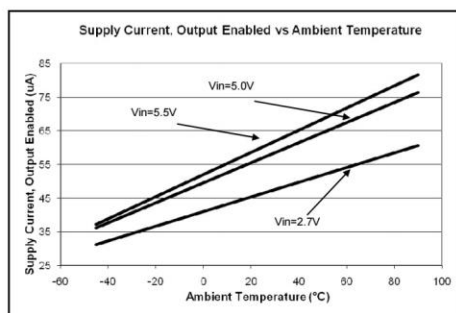
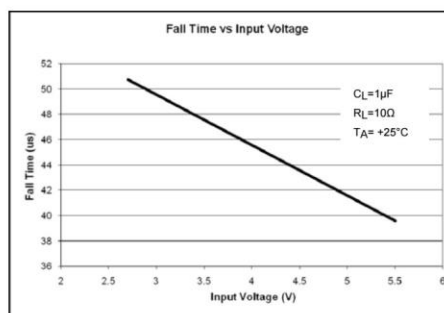
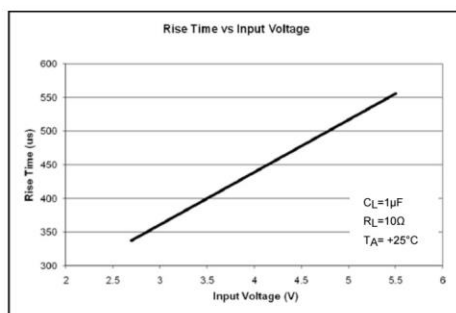
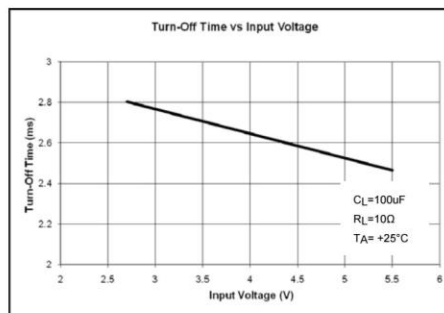
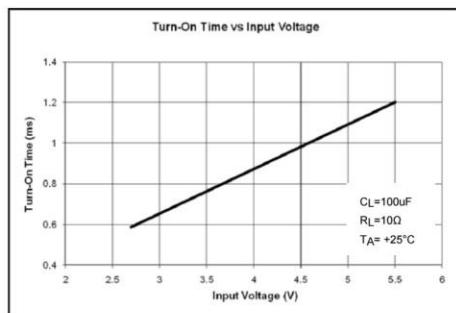
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AP2142A/ AP2152A

Typical Performance Characteristics (cont.)



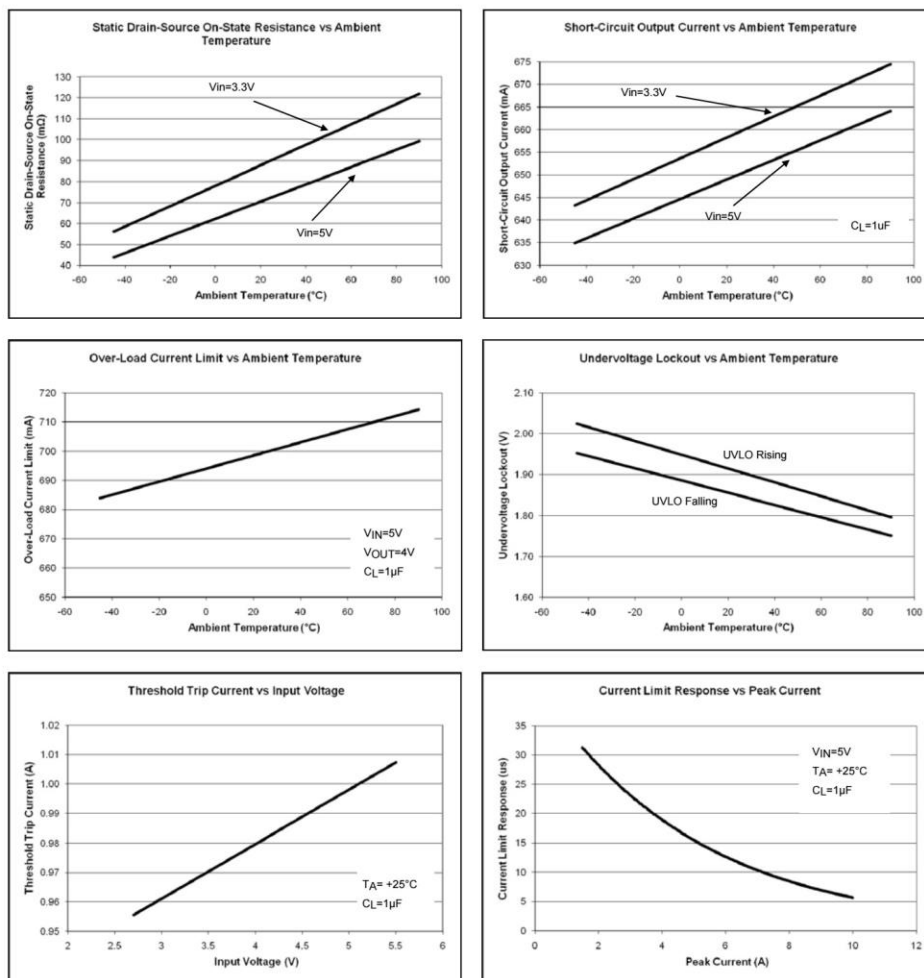
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Manuals ID 06-02



AP2142A/ AP2152A

Typical Performance Characteristics (cont.)



Enclosures

Manuals ID 06-02



AP2142A/ AP2152A

Application Information

Power Supply Considerations

A 0.1µF to 1µF X7R or X5R ceramic bypass capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the input and output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input. Additionally, bypassing the output with a 1µF ceramic capacitor improves the immunity of the device to short-circuit transients.

Over-Current and Short Circuit Protection

An internal sensing FET is employed to check for over-current conditions. Unlike current-sense resistors, sense FETs do not increase the series resistance of the current path. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault stays long enough to activate thermal limiting.

Three possible overload conditions can occur. In the first condition, the output has been shorted to GND before the device is enabled or before V_{IN} has been applied. The AP2142A/AP2152A senses the short circuit and immediately clamps output current to a certain safe level namely I_{LIMIT} .

In the second condition, an output short or an overload occurs while the device is enabled. At the instance the overload occurs, higher inrush current may flow for a very short period of time before the current limit function can react. The input capacitor(s) rapidly discharge through the device, activating current limit circuitry. Protection is achieved by momentarily opening the P-MOS high-side power switch and then gradually turning it on. After the current limit function has tripped (reached the over-current trip threshold), the device switches into current limiting mode and the current is clamped at I_{LIMIT} . The threshold for activating current limiting is 0.7A typical per channel.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold (I_{TRIP}) is reached or until the thermal limit of the device is exceeded. The AP2142A/AP2152A is capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its current limiting mode and is set at I_{LIMIT} .

FLG Response

When an over-current or over-temperature shutdown condition is encountered, the FLG open-drain output goes active low after a nominal 7-ms deglitch timeout. The FLG output remains low until both over-current and over-temperature conditions are removed. Connecting a heavy capacitive load to the output of the device can cause a momentary over-current condition, which does not trigger the FLG due to the 7-ms deglitch timeout. The AP2142A/AP2152A is designed to eliminate false over-current reporting without the need of external components to remove unwanted pulses.

Power Dissipation and Junction Temperature

The low on-resistance of the internal MOSFET allows the small surface-mount packages to pass large current. Using the maximum operating ambient temperature (T_A) and $R_{DS(ON)}$, the power dissipation can be calculated by:

$$P_D = R_{DS(ON)} \times I^2$$

Finally, calculate the junction temperature:

$$T_J = P_D \times R_{\theta JA} + T_A$$

Where:

T_A = Ambient temperature °C

$R_{\theta JA}$ = Thermal resistance

P_D = Total power dissipation

Thermal Protection

Thermal protection prevents the IC from damage when heavy-overload or short-circuit faults are present for extended periods of time. The AP2142A/AP2152A implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. Once the die temperature rises to approximately 140°C due to excessive power dissipation in an over-current or short-circuit condition the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit allowing the device to cool down approximately 25°C before the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed. The FLG open-drain output is asserted when an over-temperature shutdown or over-current occurs with 7-ms deglitch.

Enclosures

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AP2142A/ AP2152A

Application Information (cont.)

Under-Voltage Lockout (UVLO)

Under-voltage lockout function (UVLO) keeps the internal power switch from being turned on until the power supply has reached at least 2V, even if the switch is enabled. Whenever the input voltage falls below approximately 2V, the power switch is quickly turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed.

Discharge Function

The discharge function of the device is active when enable is disabled or de-asserted. The discharge function with the N-MOS power switch implementation is activated and offers a resistive discharge path for the external storage capacitor. This is designed for discharging any residue of the output voltage when either no external output resistance or load resistance is present at the output.

Host/Self-Powered HUBs

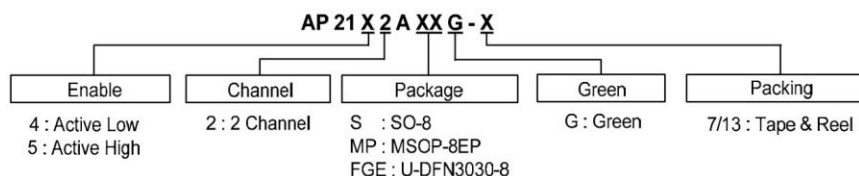
Hosts and self-powered hubs (SPH) have a local power supply that powers the embedded functions and the downstream ports. This power supply must provide from 5.25V to 4.75V to the board side of the downstream connection under both full-load and no-load conditions. Hosts and SPHs are required to have current-limit protection and must report over-current conditions to the USB controller. Typical SPHs are desktop PCs, monitors, printers, and stand-alone hubs.

Generic Hot-Plug Applications

In many applications it may be necessary to remove modules or pc boards while the main unit is still operating. These are considered hot-plug applications. Such implementations require the control of current surges seen by the main power supply and the card being inserted. The most effective way to control these surges is to limit and slowly ramp the current and voltage being applied to the card, similar to the way in which a power supply normally turns on. Due to the controlled rise times and fall times of the AP2142A/AP2152A, these devices can be used to provide a softer start-up to devices being hot-plugged into a powered system. The UVLO feature of the AP2142A/AP2152A also ensures that the switch is off after the card has been removed, and that the switch is off during the next insertion.

By placing the AP2142A/AP2152A between the VCC input and the rest of the circuitry, the input power reaches these devices first after insertion. The typical rise time of the switch is approximately 1ms, providing a slow voltage ramp at the output of the device. This implementation controls system surge current and provides a hot-plugging mechanism for any device.

Ordering Information



Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP21X2ASG-13	S	SO-8	250/Tape & Reel	-13
AP21X2AMPG-13	MP	MSOP-8EP	2500/Tape & Reel	-13
AP21X2AFGEG-7	FGE	U-DFN3030-8	3000/Tape & Reel	-7

Enclosures

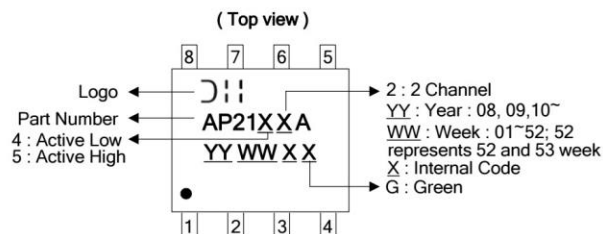
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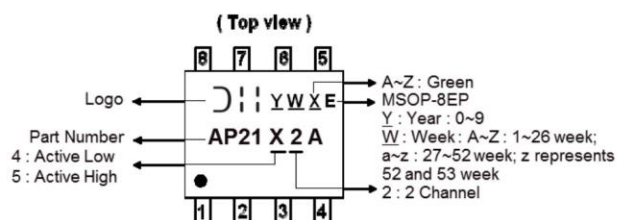
AP2142A/ AP2152A

Marking Information

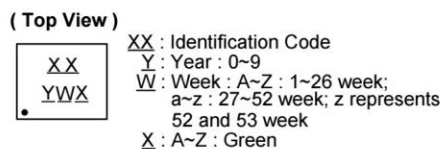
(1) SO-8



(2) MSOP-8EP



(3) U-DFN3030-8



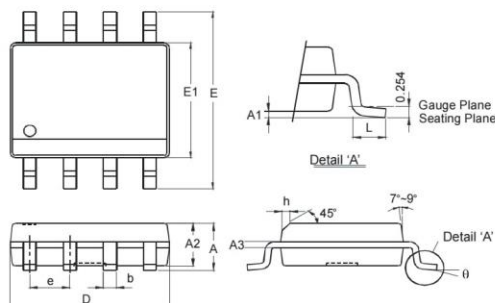
Part Number	Package	Identification Code
AP2142AFGEG-7	U-DFN3030-8	AA
AP2152AFGEG-7	U-DFN3030-8	AB

Enclosures

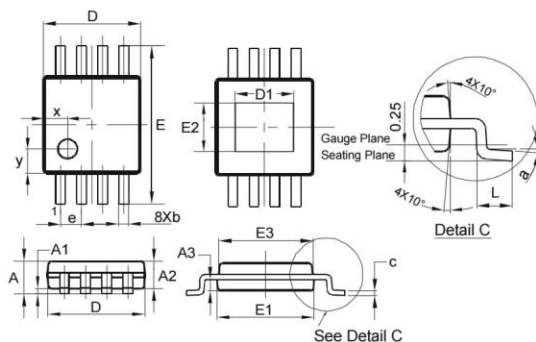
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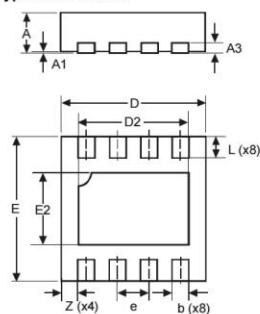
AP2142A/ AP2152A

Package Outline Dimensions (All dimensions in mm.)Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.**(1) Package Type: SO-8**

SO-8		
Dim	Min	Max
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27	Typ
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

(2) Package Type: MSOP-8EP

MSOP-8EP			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
D1	1.60	2.00	1.80
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E2	1.30	1.70	1.50
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

(3) Package Type: U-DFN3030-8

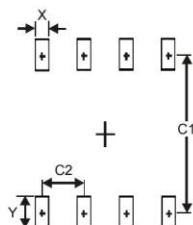
U-DFN3030-8 Type E			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.20	0.30	0.25
D	2.95	3.05	3.00
D2	2.15	2.35	2.25
E	2.95	3.05	3.00
e	-	-	0.65
E2	1.40	1.60	1.50
L	0.30	0.60	0.45
Z	-	-	0.40
All Dimensions in mm			

Enclosures

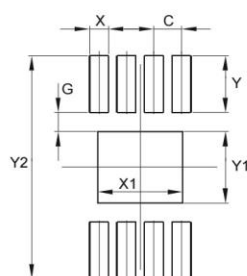
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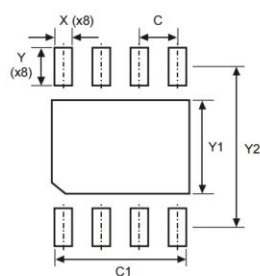
AP2142A/ AP2152A

Suggested Pad LayoutPlease see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.**(1) Package Type: SO-8**

Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

(2) Package Type: MSOP-8EP

Dimensions	Value (in mm)
C	0.650
G	0.450
X	0.450
X1	2.000
Y	1.350
Y1	1.700
Y2	5.300

(3) Package Type: U-DFN3030-8

Dimensions	Value (in mm)
C	0.65
C1	2.35
X	0.30
Y	0.65
Y1	1.60
Y2	2.75

Enclosures

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AP2142A/ AP2152A

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Manuals ID 06-03

**AP2162A/ AP2172A****1A DUAL CHANNEL CURRENT-LIMITED
POWER SWITCH WITH OUTPUT DISCHARGE****Description**

The AP2162A and AP2172A are dual channel current-limited integrated high-side power switches optimized for Universal Serial Bus (USB) and other hot-swap applications. The family of devices complies with USB standards and available with both polarities of Enable input.

The devices have fast short-circuit response time for improved overall system robustness, and have integrated output discharge function to ensure completely controlled discharging of the output voltage capacitor. They provide a complete protection solution for application subject to heavy capacitive loads and the prospect of short circuit, and offer reverse current blocking, over-current, over-temperature and short-circuit protection, as well as controlled rise time and under-voltage lockout functionality. A 7ms deglitch capability on the open-drain flag output prevents false over-current reporting and does not require any external components.

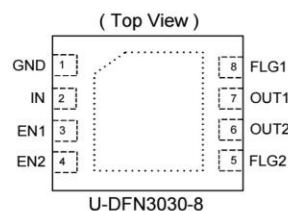
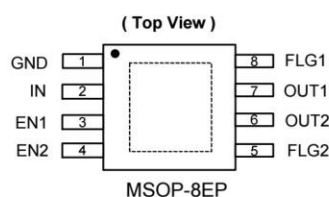
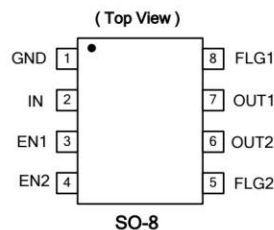
All devices are available in SO-8, MSOP-8EP and U-DFN3030-8 packages.

Features

- Dual Channel Current-Limited Power Switch with Output Discharge
- Fast Short-Circuit Response Time: 2μs
- 1.4A Accurate Current Limiting
- Reverse Current Blocking
- 85mΩ On-Resistance
- Input Voltage Range: 2.7V - 5.5V
- Built-In Soft-Start with 0.6ms Typical Rise Time
- Short Circuit and Thermal Protection
- Fault Report (FLG) with Blanking Time (7ms typ)
- ESD protection: 2kV HBM, 300V MM
- Active High (AP2172A) or Active Low (AP2162A) Enable
- Ambient Temperature Range: -40°C to +85°C
- SO-8, MSOP-8EP and DFN3030E-8 (Exposed Pad): Available in "Green" Molding Compound (No Br, Sb)
 - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
 - **Halogen and Antimony Free. "Green" Device (Note 3)**
- UL Recognized, File Number E322375
- IEC60950-1 CB Scheme Certified

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments**Applications**

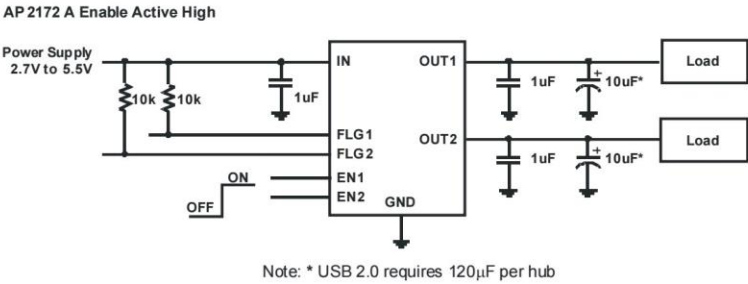
- LCD TVs & Monitors
- Set-Top-Boxes, Residential Gateways
- Laptops, Desktops, Servers,
- Printers, Docking Stations, HUBs

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AP2162A/ AP2172A

Typical Applications Circuit



Available Options

Part Number	Channel	Enable Pin (EN)	Current Limit (typ)	Recommended Maximum Continuous Load Current
AP2162A	2	Active Low	1.4A	1.0A
AP2172A	2	Active High	1.4A	1.0A

Pin Descriptions

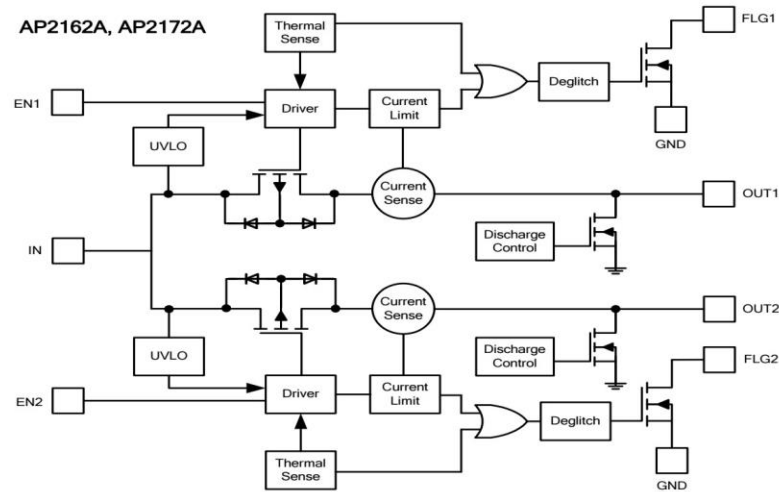
Pin Name	Pin Number		Function
	SO-8	MSOP-8EP U-DFN3030-8	
GND	1	1	Ground
IN	2	2	Voltage input pin
EN1	3	3	Switch 1 enable input, active low (AP2142A) or active high (AP2152A)
EN2	4	4	Switch 2 enable input, active low (AP2142A) or active high (AP2152A)
FLG2	5	5	Switch 2 over-current and over-temperature fault report; open-drain flag is active low when triggered
OUT2	6	6	Switch 2 voltage output pin
OUT1	7	7	Switch 1 voltage output pin
FLG1	8	8	Switch 1 over-current and over-temperature fault report; open-drain flag is active low when triggered
Exposed Pad	—	Exposed Pad	Exposed Pad: It should be connected to GND and thermal mass for enhanced thermal impedance. It should not be used as electrical ground conduction path.

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AP2162A/ AP2172A

Functional Block Diagram



Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Ratings	Unit
ESD HBM	Human Body Model ESD Protection	2	kV
ESD MM	Machine Model ESD Protection	300	V
V _{IN}	Input Voltage	6.5	V
V _{OUT}	Output Voltage	V _{IN} +0.3	V
V _{EN} , V _{FLG}	Enable Voltage	6.5	V
I _{LOAD}	Maximum Continuous Load Current	Internal Limited	A
T _{J(MAX)}	Maximum Junction Temperature	150	°C
T _{ST}	Storage Temperature Range (Note 4)	-65 to +150	°C

Note: 4. UL Recognized Rating from -30°C to +70°C (Diodes qualified T_{ST} from -65°C to +150°C)

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V _{IN}	Input Voltage	2.7	5.5	V
I _{OUT}	Output Current	0	1.0	A
V _{IH}	High-Level Input Voltage on EN or $\overline{\text{EN}}$	2	V _{IN}	V
V _{IL}	Low-Level Input Voltage on EN or $\overline{\text{EN}}$	0	0.8	V
T _A	Operating Ambient Temperature Range	-40	+85	°C

Enclosures

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AP2162A/ AP2172A

Electrical Characteristics (@T_A = +25°C, V_{IN} = +5.0V, unless otherwise specified.)

Symbol	Parameter	Test Conditions (Note 5)		Min	Typ	Max	Unit	
V _{UVLO}	Input UVLO			1.6	2.0	2.4	V	
I _{SHDN}	Input Shutdown Current	Disabled, I _{OUT} = 0			0.1	1	μA	
I _Q	Input Quiescent Current, Dual	Enabled, I _{OUT} = 0			115	180	μA	
I _{LEAK}	Input Leakage Current	Disabled, OUT grounded				1	μA	
I _{REV}	Reverse Leakage Current	Disabled, V _{IN} = 0V, V _{OUT} = 5V, I _{REV} at V _{IN}			0.01	0.1	μA	
R _{DS(ON)}	Switch On-Resistance	V _{IN} = 5V, I _{OUT} = 1A, T _A = +25°C	SO-8		90	110	mΩ	
			MSOP-8EP, U-DFN3030-8		85	105		
		V _{IN} = 5V, I _{OUT} = 1A, -40°C ≤ T _A ≤ +85°C				135		
		V _{IN} = 3.3V, I _{OUT} = 1A, T _A = +25°C	SO-8		110	130		
			MSOP-8EP, U-DFN3030-8		105	125		
		V _{IN} = 3.3V, I _{OUT} = 1A, -40°C ≤ T _A ≤ +85°C				170		
I _{LIMIT}	Over-Load Current Limit	V _{IN} = 5V, V _{OUT} = 4V, C _L = 10μF	-40°C ≤ T _A ≤ +85°C	1.1	1.4	1.7	A	
I _{LIMIT_G}	Ganged Over-Load Current Limit	V _{IN} = 5V, V _{OUT} = 4.8V, OUT1 & OUT2 tied together, C _L = 10μF	-40°C ≤ T _A ≤ +85°C	2.2	2.8	3.4	A	
I _{Trig}	Current Limiting Trigger Threshold	Output Current Slew rate (<100A/s), C _L = 10μF			1.8		A	
I _{Trig_G}	Ganged Current Limiting Trigger Threshold	OUT1 & OUT2 tied together, Output Current Slew rate (<100A/s), C _L = 10μF			3.6		A	
I _{OS}	Short-Circuit Current per Channel	OUTx connected to ground, device enabled into short circuit, C _L = 10μF			1.4		A	
I _{OS_G}	Ganged Short-Circuit Current	OUT1 & OUT2 connected to ground, device enabled into short-circuit, C _L = 10μF			2.2	2.8	3.4	A
T _{SHORT}	Short-Circuit Response Time	V _{OUT} = 0V to I _{OUT} = I _{LIMIT} (output shorted to ground)			2		μs	
V _{IL}	EN Input Logic Low Voltage	V _{IN} = 2.7V to 5.5V				0.8	V	
V _{IH}	EN Input Logic High Voltage	V _{IN} = 2.7V to 5.5V			2		V	
I _{SINK}	EN Input Leakage	V _{EN} = 0V to 5.5V				1	μA	
I _{LEAK-O}	Output Leakage Current	Disabled, V _{OUT} = 0V			0.5	1	μA	
T _R	Output Turn-On Rise Time	C _L = 1μF, R _{LOAD} = 5Ω				0.6	1.5	ms
T _F	Output Turn-Off Fall Time	C _L = 1μF, R _{LOAD} = 5Ω				0.05	0.3	ms
T _{D(ON)}	Output Turn-On Delay Time	C _L = 100μF, R _{LOAD} = 5Ω				0.2	0.5	ms
T _{D(OFF)}	Output Turn-Off Delay Time	C _L = 100μF, R _{LOAD} = 5Ω				0.1	0.3	ms
R _{FLG}	FLG Output FET On-Resistance	I _{FLG} = 10mA				20	40	Ω
I _{FOH}	FLG Off Current	V _{FLG} = 5V				0.01	1	μA
T _{Blank}	FLG Blanking Time	C _L = 10μF			4	7	15	ms
R _{DIS}	Discharge Resistance (Note 6)	V _{IN} = 5V, disabled, I _{OUT} = 1mA				100		Ω
T _{SHDN}	Thermal Shutdown Threshold	Enabled, R _{LOAD} = 1kΩ				140		°C
T _{HYS}	Thermal Shutdown Hysteresis					25		°C
θ _{JA}	Thermal Resistance Junction-to-Ambient	SO-8 (Note 7)			115		°C/W	
		MSOP-8EP (Note 8)			75			
		U-DFN3030-8 (Note 8)			60			

Notes:

- Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.
- The discharge function is active when the device is disabled (when enable is de-asserted or during power-up / power-down when V_{IN} < V_{UVLO}). The discharge function offers a resistive discharge path for the external storage capacitor for limited time.
- Test condition for SO-8: Device mounted on FR-4 substrate PCB with minimum recommended pad layout.
- Test condition for MSOP-8EP and U-DFN3030-8: Device mounted on 2" x 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

Enclosures

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AP2162A/ AP2172A

Typical Performance Characteristics

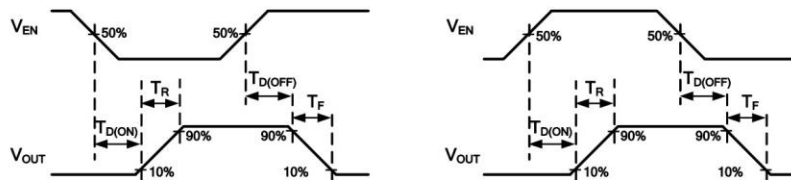


Figure 1 Voltage Waveforms: AP2162A (left), AP2172A (right)

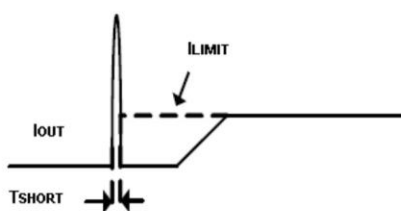
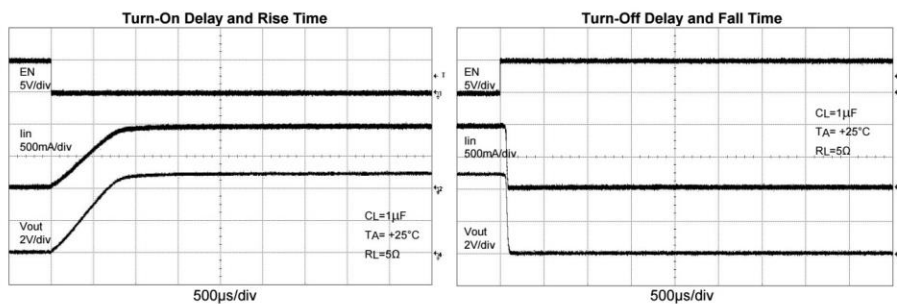


Figure 2 Response Time to Short Circuit Waveform

All Enable Plots are for AP2162A Active Low



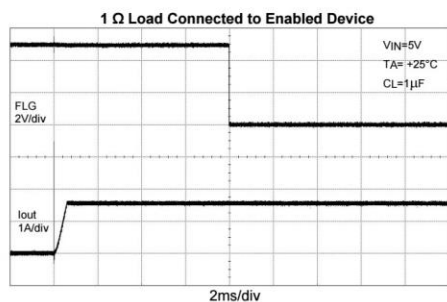
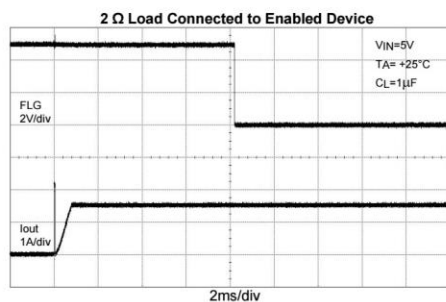
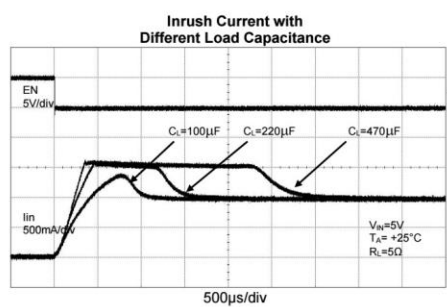
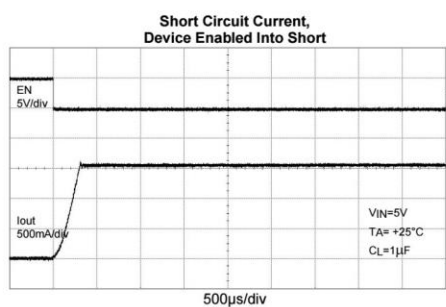
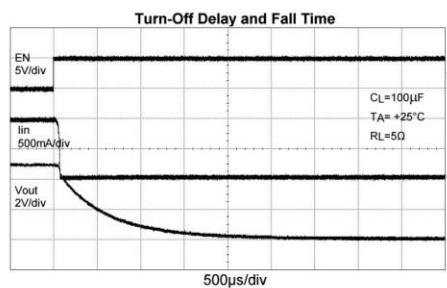
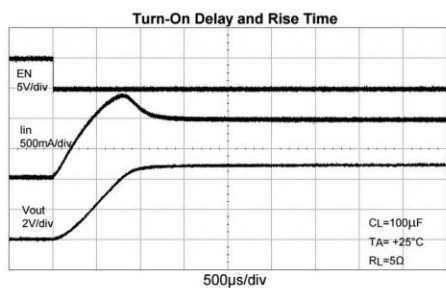
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AP2162A/ AP2172A

Typical Performance Characteristics (cont.)



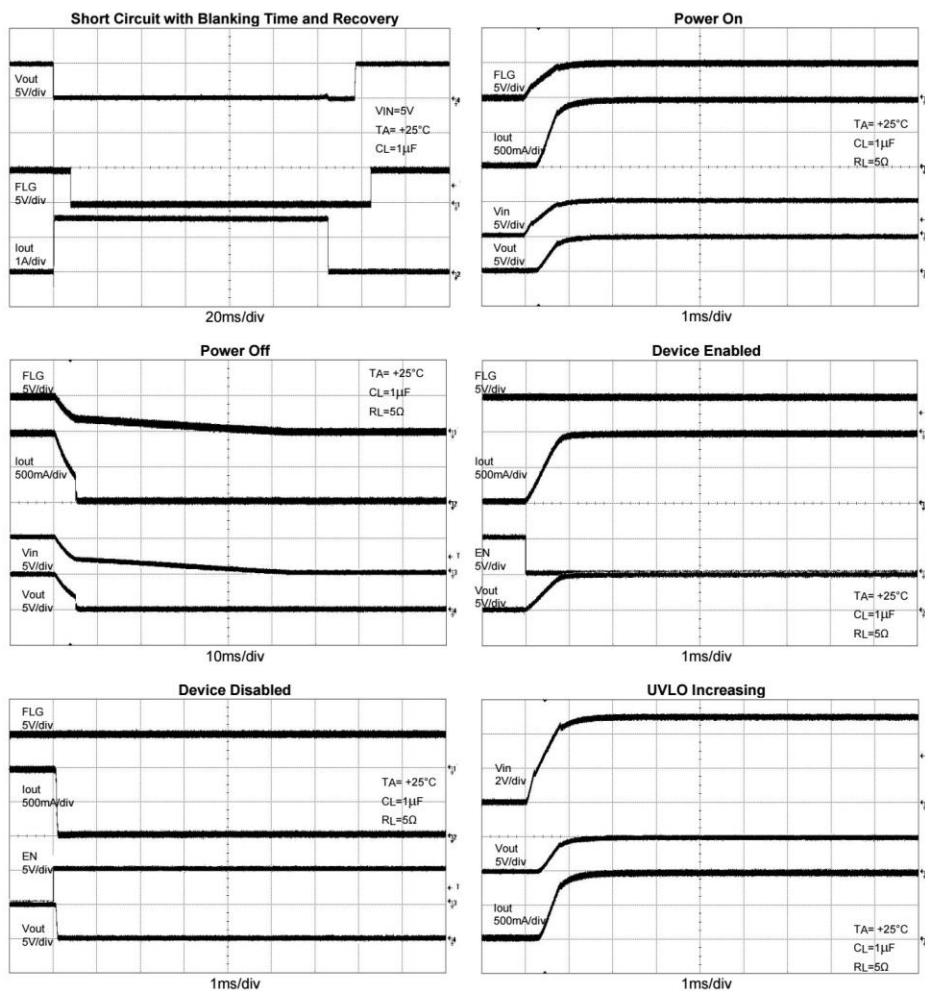
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AP2162A/ AP2172A

Typical Performance Characteristics (cont.)



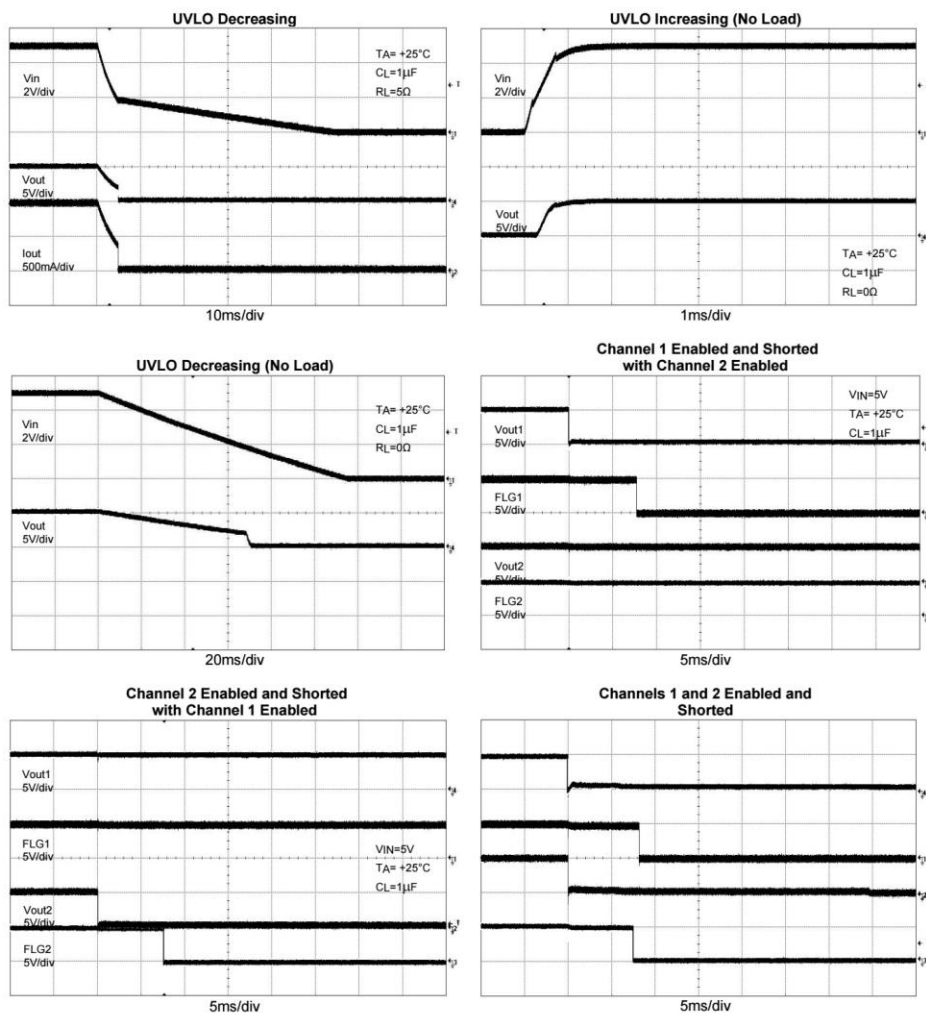
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AP2162A/ AP2172A

Typical Performance Characteristics (cont.)



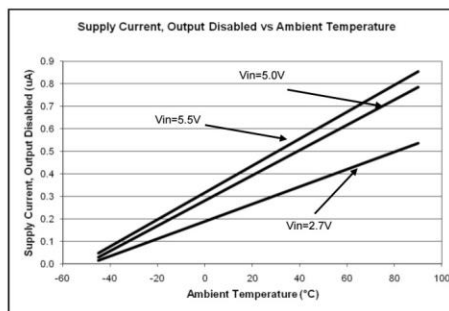
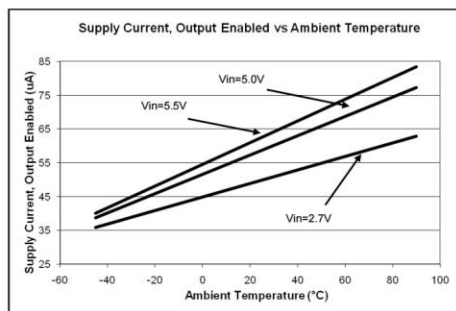
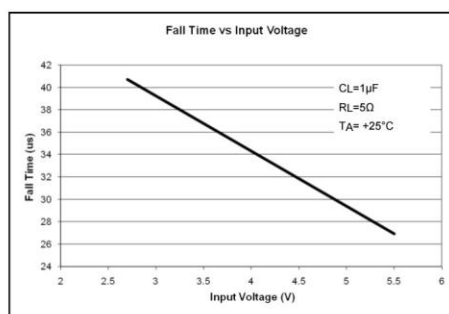
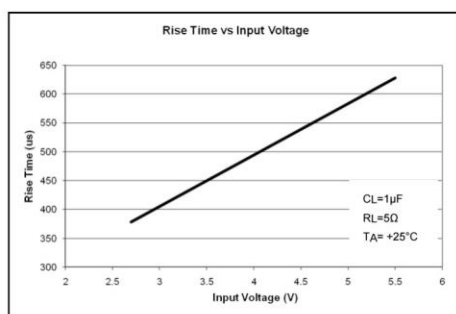
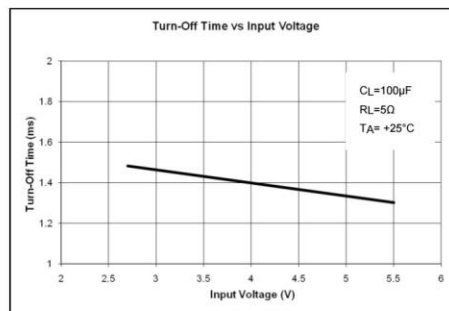
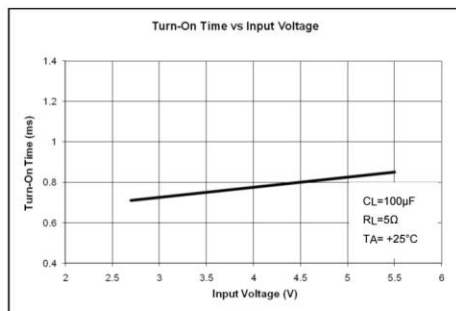
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AP2162A/ AP2172A

Typical Performance Characteristics (cont.)



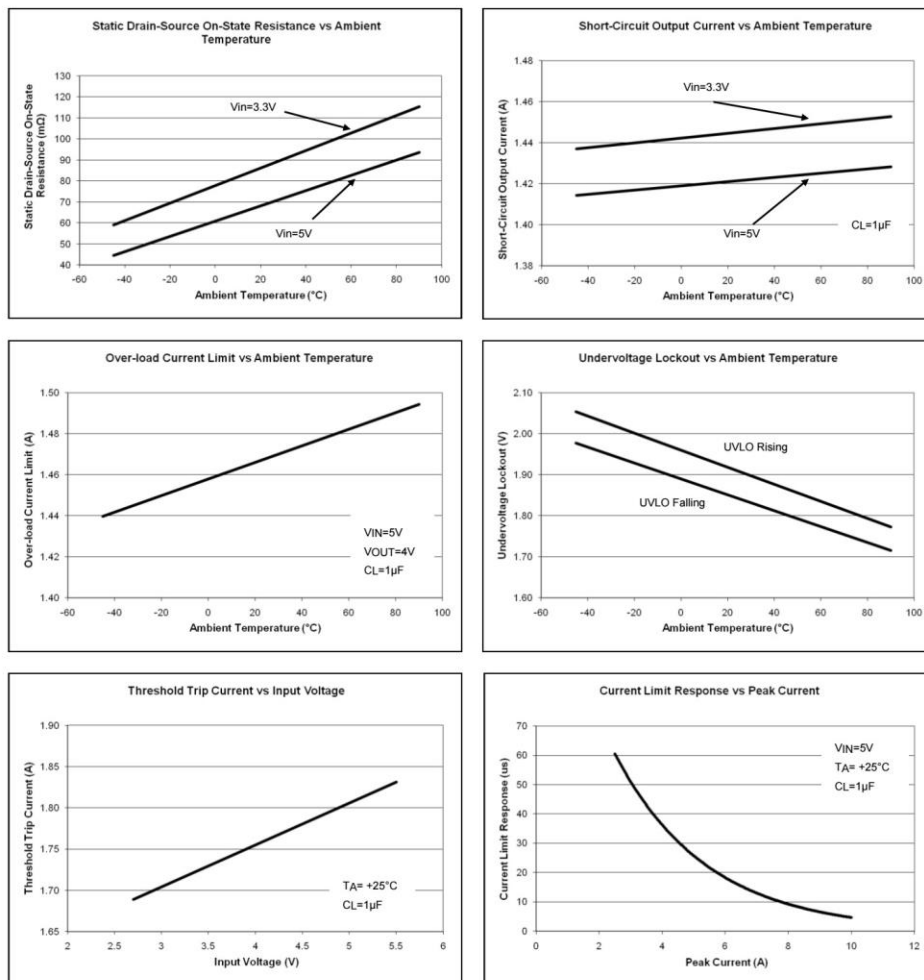
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AP2162A/ AP2172A

Typical Performance Characteristics (cont.)



Enclosures

Manuals ID 06-03



AP2162A/ AP2172A

Application Information

Power Supply Considerations

A 0.1µF to 1µF X7R or X5R ceramic bypass capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the input and output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input. Additionally, bypassing the output with a 1µF ceramic capacitor improves the immunity of the device to short-circuit transients.

Over-Current and Short Circuit Protection

An internal sensing FET is employed to check for over-current conditions. Unlike current-sense resistors, sense FETs do not increase the series resistance of the current path. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault stays long enough to activate thermal limiting.

Three possible overload conditions can occur. In the first condition, the output has been shorted to GND before the device is enabled or before V_{IN} has been applied. The AP2162A/AP2172A senses the short circuit and immediately clamps output current to a certain safe level namely I_{LIMIT} .

In the second condition, an output short or an overload occurs while the device is enabled. At the instance the overload occurs, higher inrush current may flow for a very short period of time before the current limit function can react. The input capacitor(s) rapidly discharge through the device, activating current limit circuitry. Protection is achieved by momentarily opening the P-MOS high-side power switch and then gradually turning it on. After the current limit function has tripped (reached the over-current trip threshold), the device switches into current limiting mode and the current is clamped at I_{LIMIT} . The threshold for activating current limiting is 1.4A typical per channel.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold (I_{TRIP}) is reached or until the thermal limit of the device is exceeded. The AP2162A/AP2172A is capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its current limiting mode and is set at I_{LIMIT} .

FLG Response

When an over-current or over-temperature shutdown condition is encountered, the FLG open-drain output goes active low after a nominal 7-ms deglitch timeout. The FLG output remains low until both over-current and over-temperature conditions are removed. Connecting a heavy capacitive load to the output of the device can cause a momentary over-current condition, which does not trigger the FLG due to the 7-ms deglitch timeout. The AP2162A/AP2172A is designed to eliminate false over-current reporting without the need of external components to remove unwanted pulses.

Power Dissipation and Junction Temperature

The low on-resistance of the internal MOSFET allows the small surface-mount packages to pass large current. Using the maximum operating ambient temperature (T_A) and $R_{DS(ON)}$, the power dissipation can be calculated by:

$$P_D = R_{DS(ON)} \times I^2$$

Finally, calculate the junction temperature:

$$T_J = P_D \times R_{\theta JA} + T_A$$

Where:

T_A = Ambient temperature °C

$R_{\theta JA}$ = Thermal resistance

P_D = Total power dissipation

Thermal Protection

Thermal protection prevents the IC from damage when heavy-overload or short-circuit faults are present for extended periods of time. The AP2162A/AP2172A implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. Once the die temperature rises to approximately 140°C due to excessive power dissipation in an over-current or short-circuit condition the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit allowing the device to cool down approximately 25°C before the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed. The FLG open-drain output is asserted when an over-temperature shutdown or over-current occurs with 7-ms deglitch.

Enclosures

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AP2162A/ AP2172A

Application Information (cont.)

Under-Voltage Lockout (UVLO)

Under-voltage lockout function (UVLO) keeps the internal power switch from being turned on until the power supply has reached at least 2V, even if the switch is enabled. Whenever the input voltage falls below approximately 2V, the power switch is quickly turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed.

Discharge Function

The discharge function of the device is active when enable is disabled or de-asserted. The discharge function with the N-MOS power switch implementation is activated and offers a resistive discharge path for the external storage capacitor. This is designed for discharging any residue of the output voltage when either no external output resistance or load resistance is present at the output.

Host/Self-Powered HUBs

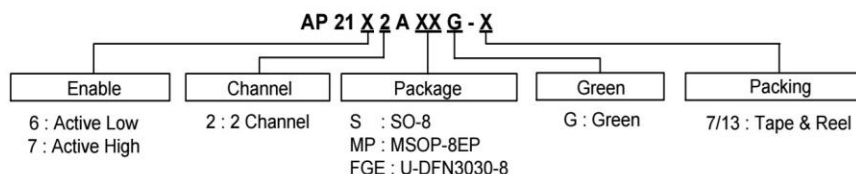
Hosts and self-powered hubs (SPH) have a local power supply that powers the embedded functions and the downstream ports. This power supply must provide from 5.25V to 4.75V to the board side of the downstream connection under both full-load and no-load conditions. Hosts and SPHs are required to have current-limit protection and must report over-current conditions to the USB controller. Typical SPHs are desktop PCs, monitors, printers, and stand-alone hubs.

Generic Hot-Plug Applications

In many applications it may be necessary to remove modules or pc boards while the main unit is still operating. These are considered hot-plug applications. Such implementations require the control of current surges seen by the main power supply and the card being inserted. The most effective way to control these surges is to limit and slowly ramp the current and voltage being applied to the card, similar to the way in which a power supply normally turns on. Due to the controlled rise times and fall times of the AP2162A/AP2172A, these devices can be used to provide a softer start-up to devices being hot-plugged into a powered system. The UVLO feature of the AP2162A/AP2172A also ensures that the switch is off after the card has been removed, and that the switch is off during the next insertion.

By placing the AP2162A/AP2172A between the VCC input and the rest of the circuitry, the input power reaches these devices first after insertion. The typical rise time of the switch is approximately 1ms, providing a slow voltage ramp at the output of the device. This implementation controls system surge current and provides a hot-plugging mechanism for any device.

Ordering Information



Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP21X2ASG-13	S	SO-8	250/Tape & Reel	-13
AP21X2AMPG-13	MP	MSOP-8EP	2500/Tape & Reel	-13
AP21X2AFGEG-7	FGE	U-DFN3030-8	3000/Tape & Reel	-7

Enclosures

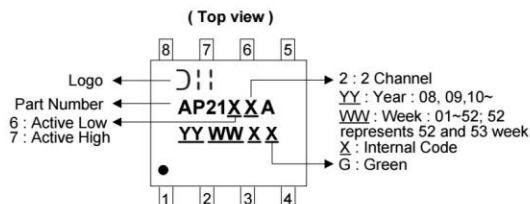
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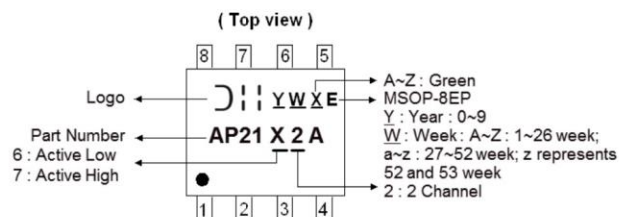
AP2162A/ AP2172A

Marking Information

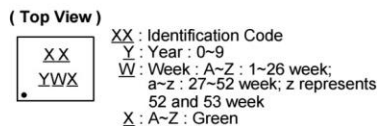
(1) SO-8



(2) MSOP-8EP



(3) U-DFN3030-8



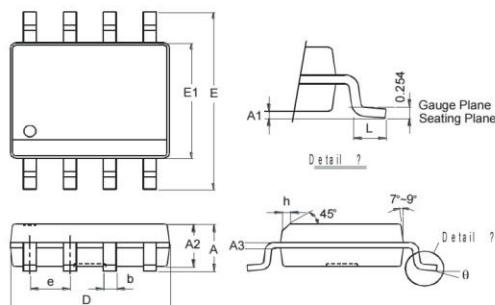
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AP2172AFGEG-7	U-DFN3030-8	AB

Enclosures

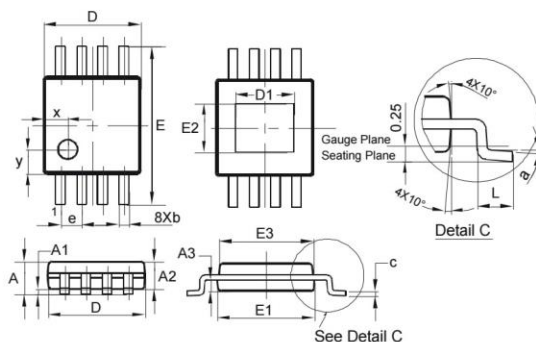
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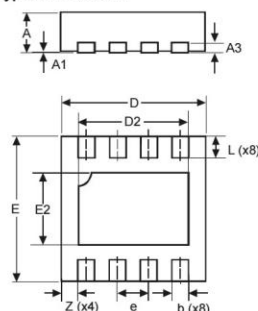
AP2162A/ AP2172A

Package Outline Dimensions (All dimensions in mm.)Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.**(1) Package Type: SO-8**

SO-8		
Dim	Min	Max
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27	Typ
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

(2) Package Type: MSOP-8EP

MSOP-8EP			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
D1	1.60	2.00	1.80
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E2	1.30	1.70	1.50
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

(3) Package Type: U-DFN3030-8

U-DFN3030-8 Type E			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.20	0.30	0.25
D	2.95	3.05	3.00
D2	2.15	2.35	2.25
E	2.95	3.05	3.00
e	-	-	0.65
E2	1.40	1.60	1.50
L	0.30	0.60	0.45
Z	-	-	0.40
All Dimensions in mm			

Enclosures

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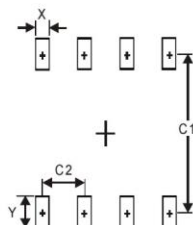


AP2162A/ AP2172A

Suggested Pad Layout

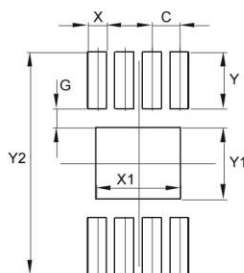
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(1) Package Type: SO-8



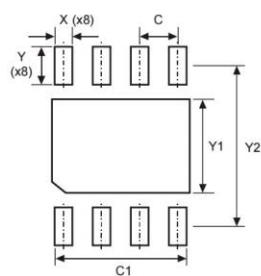
Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

(2) Package Type: MSOP-8EP



Dimensions	Value (in mm)
C	0.650
G	0.450
X	0.450
X1	2.000
Y	1.350
Y1	1.700
Y2	5.300

(3) Package Type: U-DFN3030-8



Dimensions	Value (in mm)
C	0.65
C1	2.35
X	0.30
Y	0.65
Y1	1.60
Y2	2.75

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AP2162A/ AP2172A

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Manuals ID 06-04



Lead-free Green

AP2182A/ AP2192A**1.5A DUAL CHANNEL CURRENT-LIMITED POWER SWITCH****Description**

The AP2182A and AP2192A are dual channel current-limited integrated high-side power switches optimized for Universal Serial Bus (USB) and other hot-swap applications. The family of devices complies with USB standards and available with both polarities of Enable input.

The devices have fast short-circuit response time for improved overall system robustness, and have integrated output discharge function to ensure completely controlled discharging of the output voltage capacitor. They provide a complete protection solution for application subject to heavy capacitive loads and the prospect of short circuit, and offer reverse current blocking, over-current, over-temperature and short-circuit protection, as well as controlled rise time and under-voltage lockout functionality. A 7ms deglitch capability on the open-drain Flag output prevents false over-current reporting and does not require any external components.

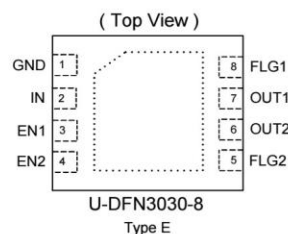
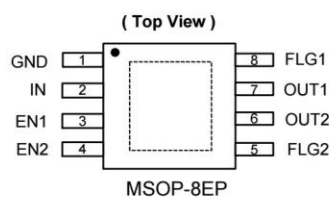
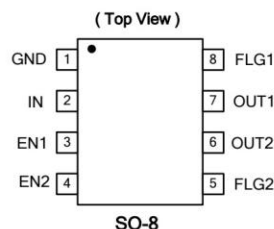
All devices are available in SO-8, MSOP-8EP and U-DFN3030-8 (Type E) packages.

Features

- Dual Channel Current-Limited Power Switch with Output Discharge
- Fast Short-Circuit Response Time: 2μs
- 2.0A Accurate Current Limiting
- Reverse Current Blocking
- 85mΩ On-Resistance
- Input Voltage Range: 2.7V - 5.5V
- Built-In Soft-Start with 0.6ms Typical Rise Time
- Short Circuit and Thermal Protection
- Fault Report (FLG) with Blanking Time (7ms typ)
- ESD protection: 2kV HBM, 300V MM
- Active High (AP2192A) or Active Low (AP2182A) Enable
- Ambient Temperature Range: -40°C to +85°C
- SO-8, MSOP-8EP and DFN3030E-8 (Exposed Pad): Available in "Green" Molding Compound (No Br, Sb)
 - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
 - **Halogen and Antimony Free. "Green" Device (Note 3)**
- UL Recognized, File Number E322375
- IEC60950-1 CB Scheme Certified

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

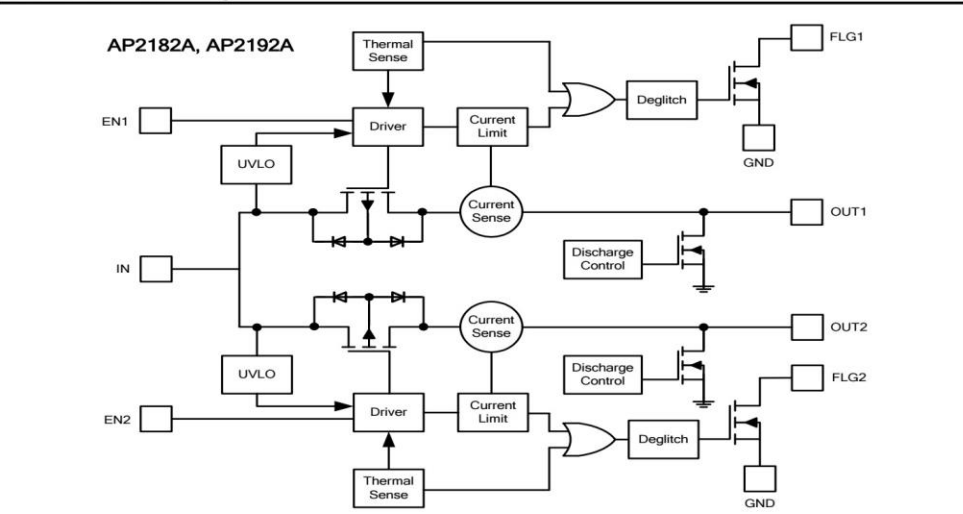
Pin Assignments**Applications**

- LCD TVs & Monitors
- Set-Top-Boxes, Residential Gateways
- Laptops, Desktops, Servers,
- Printers, Docking Stations, HUBs

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Functional Block Diagram



Absolute Maximum Ratings (@T _A = +25°C, unless otherwise specified.)			
Symbol	Parameter	Ratings	Unit
ESD HBM	Human Body Model ESD Protection	2	kV
ESD MM	Machine Model ESD Protection	300	V
V _{IN}	Input Voltage	6.5	V
V _{OUT}	Output Voltage	V _{IN} +0.3	V
V _{EN} , V _{FLG}	Enable Voltage	6.5	V
I _{LOAD}	Maximum Continuous Load Current	Internal Limited	A
T _{J(MAX)}	Maximum Junction Temperature	150	°C
T _{ST}	Storage Temperature Range (Note 4)	-65 to +150	°C

Note: 4. UL Recognized Rating from -30°C to +70°C (Diodes qualified T_{ST} from -65°C to +150°C).

Recommended Operating Conditions (@T _A = +25°C, unless otherwise specified.)				
Symbol	Parameter	Min	Max	Unit
V _{IN}	Input Voltage	2.7	5.5	V
I _{OUT}	Output Current	0	1.5	A
V _{IH}	High-Level Input Voltage on EN or $\overline{\text{EN}}$	2	V _{IN}	V
V _{IL}	Low-Level Input Voltage on EN or $\overline{\text{EN}}$	0	0.8	V
T _A	Operating Ambient Temperature Range	-40	+85	°C

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AP2182A/ AP2192A

Electrical Characteristics (@T_A = +25°C, V_{IN} = +5.0V, unless otherwise specified.)

Symbol	Parameter	Test Conditions (Note 5)	Min	Typ	Max	Unit
V _{UVLO}	Input UVLO	-	1.6	2.0	2.4	V
I _{SHDN}	Input Shutdown Current	Disabled, I _{OUT} = 0	-	0.1	1	μA
I _Q	Input Quiescent Current, Dual	Enabled, I _{OUT} = 0	-	115	180	μA
I _{LEAK}	Input Leakage Current	Disabled, OUT grounded	-	-	1	μA
I _{REV}	Reverse Leakage Current	Disabled, V _{IN} = 0V, V _{OUT} = 5V, I _{REV} at V _{IN}	-	0.01	0.1	μA
R _{DS(ON)}	Switch On-Resistance	V _{IN} = 5V, I _{OUT} = 1.5A, T _A = +25°C	-	90	110	mΩ
		SO-8	-	-	-	
		MSOP-8EP, U-DFN3030-8 (Type E)	-	85	105	
		V _{IN} = 5V, I _{OUT} = 1.5A, -40°C ≤ T _A ≤ +85°C	-	-	135	
		V _{IN} = 3.3V, I _{OUT} = 1.5A, T _A = +25°C	-	110	130	mΩ
		SO-8	-	-	-	
		MSOP-8EP, U-DFN3030-8 (Type E)	-	105	125	
		V _{IN} = 3.3V, I _{OUT} = 1.5A, -40°C ≤ T _A ≤ +85°C	-	-	170	-
I _{LIMIT}	Overload Current Limit	V _{IN} = 5V, V _{OUT} = 4V, C _L = 10μF	1.6	2.0	2.4	A
I _{LIMIT_G}	Ganged Overload Current Limit	V _{IN} = 5V, V _{OUT} = 4.6V, OUT1 & OUT2 tied together, C _L = 10μF	3.2	4.0	4.8	A
I _{TRIG}	Current Limiting Trigger Threshold	Output Current Slew rate (<100A/s), C _L = 10μF	-	2.5	-	A
I _{TRIG_G}	Ganged Current Limiting Trigger Threshold	OUT1 & OUT2 tied together, Output Current Slew rate (<100A/s), C _L = 10μF	-	5.0	-	A
I _{OS}	Short-Circuit Current per Channel	OUTx connected to ground, device enabled into short circuit, C _L = 10μF	-	2.0	-	A
I _{OS_G}	Ganged Short-Circuit Current	OUT1 & OUT2 connected to ground, device enabled into short-circuit, C _L = 10μF	3.2	4.0	4.8	A
T _{SHORT}	Short-Circuit Response Time	V _{OUT} = 0V to I _{OUT} = I _{LIMIT} (output shorted to ground)	-	2	-	μs
V _{IL}	EN Input Logic Low Voltage	V _{IN} = 2.7V to 5.5V	-	-	0.8	V
V _{IH}	EN Input Logic High Voltage	V _{IN} = 2.7V to 5.5V	2	-	-	V
I _{SINK}	EN Input Leakage	V _{EN} = 0V to 5.5V	-	-	1	μA
I _{LEAK-O}	Output Leakage Current	Disabled, V _{OUT} = 0V	-	0.5	1	μA
T _R	Output Turn-On Rise Time	C _L = 1μF, R _{LOAD} = 5Ω	-	0.6	1.5	ms
T _F	Output Turn-Off Fall Time	C _L = 1μF, R _{LOAD} = 5Ω	-	0.05	0.3	ms
T _{D(ON)}	Output Turn-On Delay Time	C _L = 100μF, R _{LOAD} = 5Ω	-	0.2	0.5	ms
T _{D(OFF)}	Output Turn-Off Delay Time	C _L = 100μF, R _{LOAD} = 5Ω	-	0.1	0.3	ms
R _{FLG}	FLG Output FET On-Resistance	I _{FLG} = 10mA	-	20	40	Ω
I _{FOH}	FLG Off Current	V _{FLG} = 5V	-	0.01	1	μA
T _{Blank}	FLG Blanking Time	C _L = 10μF	4	7	15	ms
R _{DIS}	Discharge Resistance (Note 6)	V _{IN} = 5V, disabled, I _{OUT} = 1mA	-	100	-	Ω
T _{SHDN}	Thermal Shutdown Threshold	Enabled, R _{LOAD} = 1kΩ	-	140	-	°C
T _{HYS}	Thermal Shutdown Hysteresis	-	-	25	-	°C
θ _{JA}	Thermal Resistance Junction-to-Ambient	SO-8 (Note 7)	-	115	-	°C/W
		MSOP-8EP (Note 8)	-	75	-	
		U-DFN3030-8 (Type E) (Note 8)	-	60	-	

- Notes:
5. Pulse-testing techniques maintain junction temperature close to ambient temperature; thermal effects must be taken into account separately.
 6. The discharge function is active when the device is disabled (when enable is de-asserted or during power-up / power-down when V_{IN} < V_{UVLO}). The discharge function offers a resistive discharge path for the external storage capacitor for limited time.
 7. Test condition for SO-8: Device mounted on FR-4 substrate PCB with minimum recommended pad layout.
 8. Test condition for MSOP-8EP and U-DFN3030-8 (Type E): Device mounted on 2" x 2" FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

Enclosures

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AP2182A/ AP2192A

Typical Performance Characteristics

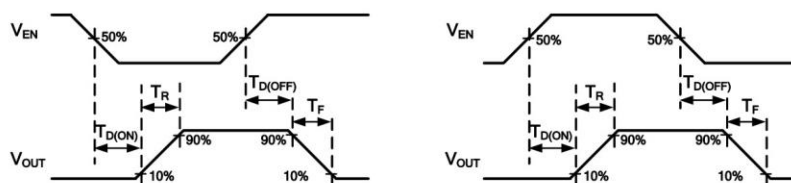


Figure 1. Voltage Waveforms: AP2182A (left), AP2192A (right)

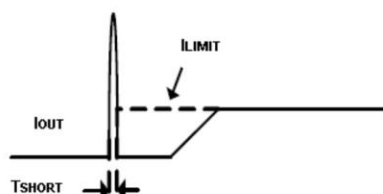
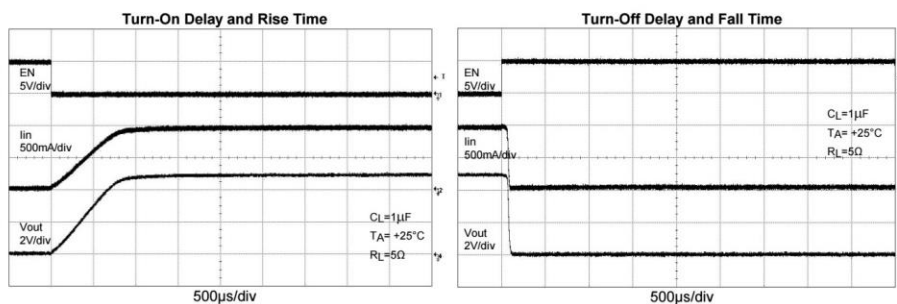


Figure 2. Response Time to Short Circuit Waveform

All Enable Plots are for AP2182A Active Low



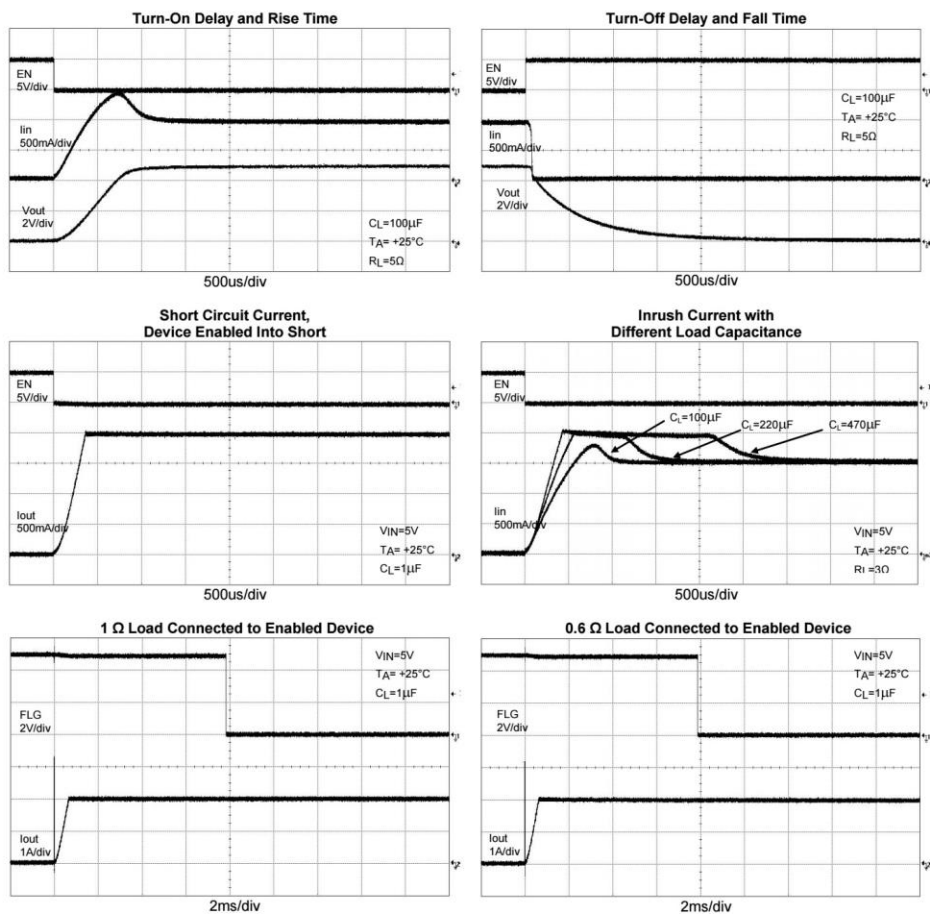
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AP2182A/ AP2192A

Typical Performance Characteristics (continued)



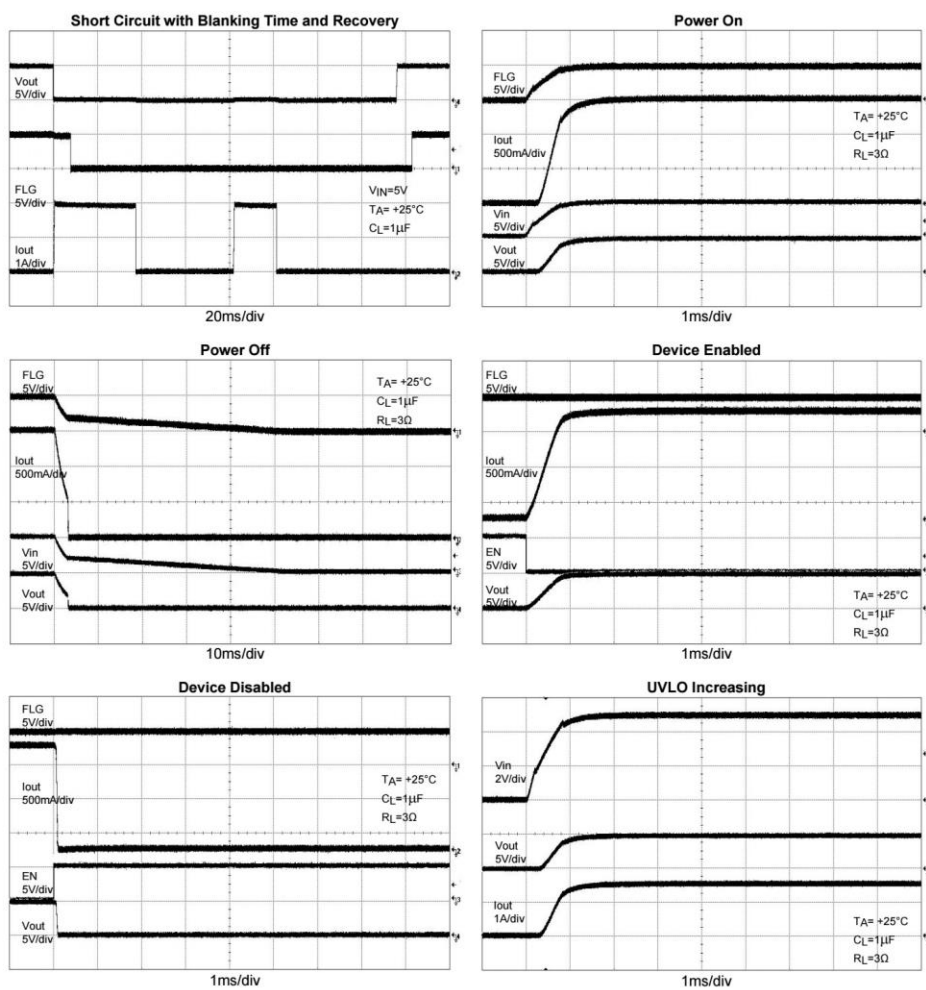
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AP2182A/ AP2192A

Typical Performance Characteristics (cont.)



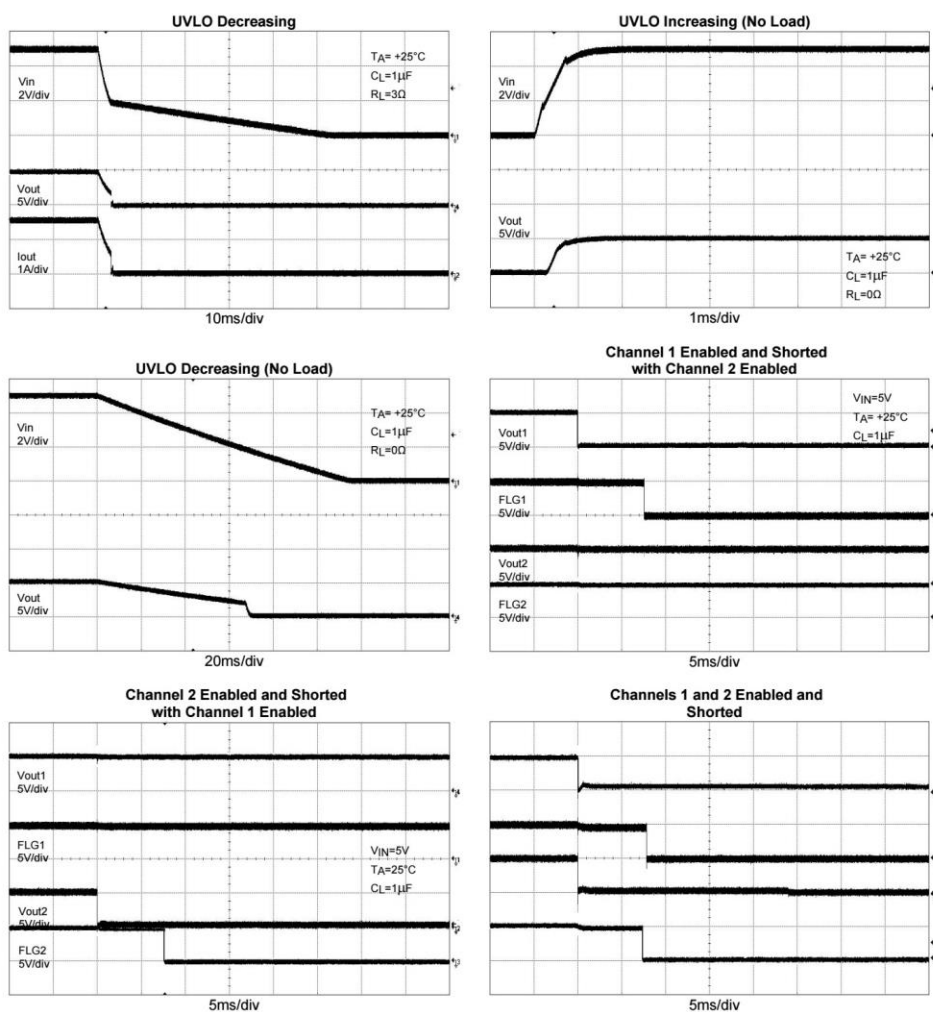
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AP2182A/ AP2192A

Typical Performance Characteristics (cont.)



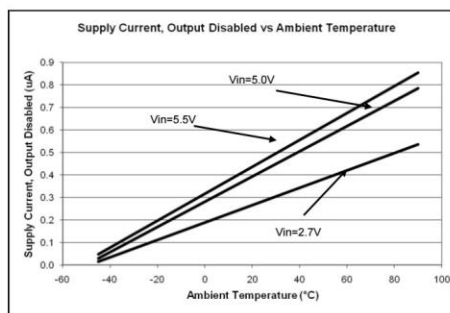
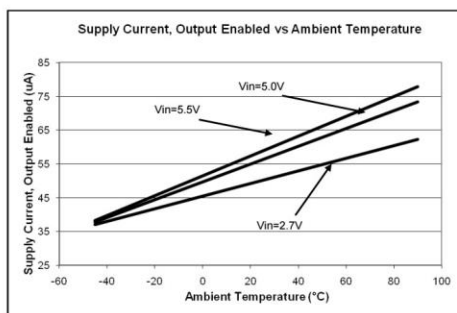
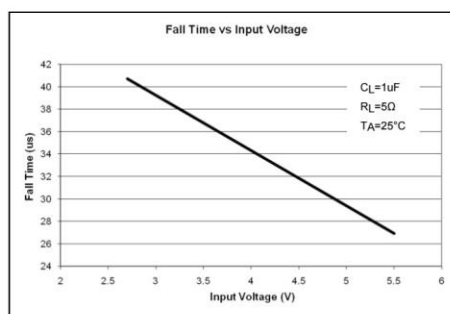
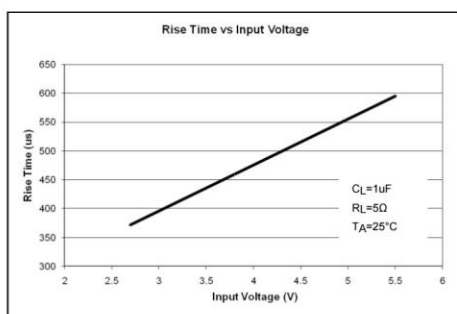
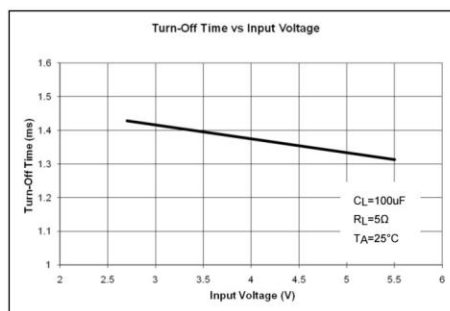
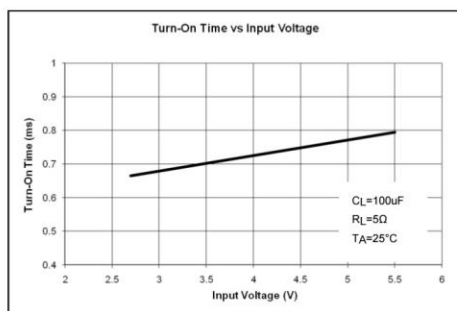
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AP2182A/ AP2192A

Typical Performance Characteristics (cont.)



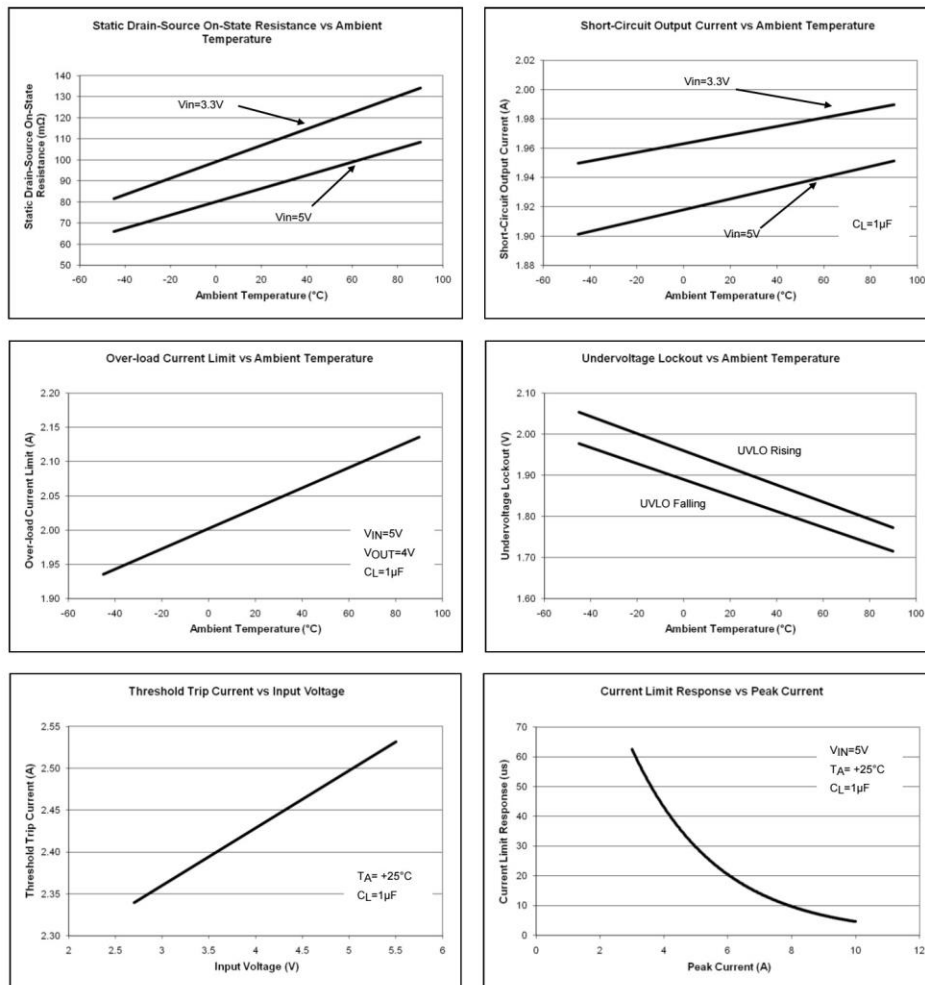
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Manuals ID 06-04



AP2182A/ AP2192A

Typical Performance Characteristics (cont.)



Enclosures

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AP2182A/ AP2192A

Application Information

Power Supply Considerations

A 0.1µF to 1µF X7R or X5R ceramic bypass capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the input and output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input. Additionally, bypassing the output with a 1µF ceramic capacitor improves the immunity of the device to short-circuit transients.

Overcurrent and Short Circuit Protection

An internal sensing FET is employed to check for overcurrent conditions. Unlike current-sense resistors, sense FETs do not increase the series resistance of the current path. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault stays long enough to activate thermal limiting.

Three possible overload conditions can occur. In the first condition, the output has been shorted to GND before the device is enabled or before V_{IN} has been applied. The AP2182A/AP2192A senses the short circuit and immediately clamps output current to a certain safe level namely I_{LIMIT} .

In the second condition, an output short or an overload occurs while the device is enabled. At the instance the overload occurs, higher inrush current may flow for a very short period of time before the current limit function can react. The input capacitor(s) rapidly discharge through the device, activating current limit circuitry. Protection is achieved by momentarily opening the P-MOS high-side power switch and then gradually turning it on. After the current limit function has tripped (reached the over-current trip threshold), the device switches into current limiting mode and the current is clamped at I_{LIMIT} . The threshold for activating current limiting is 2A typical per channel.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold (I_{TRIP}) is reached or until the thermal limit of the device is exceeded. The AP2182A/AP2192A is capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its current limiting mode and is set at I_{LIMIT} .

FLG Response

When an overcurrent or overtemperature shutdown condition is encountered, the FLG open-drain output goes active low after a nominal 7-ms deglitch timeout. The FLG output remains low until both overcurrent and overtemperature conditions are removed. Connecting a heavy capacitive load to the output of the device can cause a momentary overcurrent condition, which does not trigger the FLG due to the 7-ms deglitch timeout. The AP2182A/AP2192A is designed to eliminate false over-current reporting without the need of external components to remove unwanted pulses.

Power Dissipation and Junction Temperature

The low on-resistance of the internal MOSFET allows the small surface-mount packages to pass large current. Using the maximum operating ambient temperature (T_A) and $R_{DS(ON)}$, the power dissipation can be calculated by:

$$P_D = R_{DS(ON)} \times I^2$$

Finally, calculate the junction temperature:

$$T_J = P_D \times R_{\theta JA} + T_A$$

Where:

T_A = Ambient temperature °C

$R_{\theta JA}$ = Thermal resistance

P_D = Total power dissipation

Thermal Protection

Thermal protection prevents the IC from damage when heavy-overload or short-circuit faults are present for extended periods of time. The AP2182A/AP2192A implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. Once the die temperature rises to approximately 140°C due to excessive power dissipation in an overcurrent or short-circuit condition the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit allowing the device to cool down approximately 25°C before the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed. The FLG open-drain output is asserted when an overtemperature shutdown or overcurrent occurs with 7-ms deglitch.

Enclosures

Manuals ID 06-04



AP2182A/ AP2192A

Application Information (cont.)**Undervoltage Lockout (UVLO)**

Undervoltage lockout function (UVLO) keeps the internal power switch from being turned on until the power supply has reached at least 2V, even if the switch is enabled. Whenever the input voltage falls below approximately 2V, the power switch is quickly turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed.

Discharge Function

The discharge function of the device is active when enable is disabled or de-asserted. The discharge function with the N-MOS power switch implementation is activated and offers a resistive discharge path for the external storage capacitor. This is designed for discharging any residue of the output voltage when either no external output resistance or load resistance is present at the output.

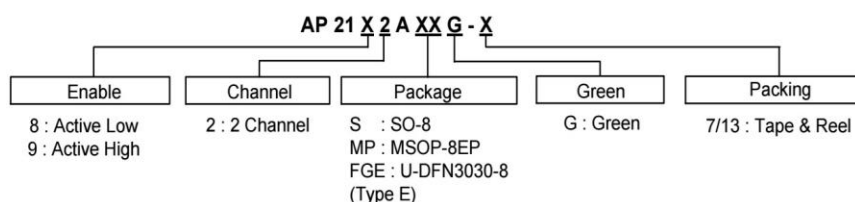
Host/Self-Powered HUBs

Hosts and self-powered hubs (SPH) have a local power supply that powers the embedded functions and the downstream ports. This power supply must provide from 5.25V to 4.75V to the board side of the downstream connection under both full-load and no-load conditions. Hosts and SPHs are required to have current-limit protection and must report overcurrent conditions to the USB controller. Typical SPHs are desktop PCs, monitors, printers, and stand-alone hubs.

Generic Hot-Plug Applications

In many applications it may be necessary to remove modules or pc boards while the main unit is still operating. These are considered hot-plug applications. Such implementations require the control of current surges seen by the main power supply and the card being inserted. The most effective way to control these surges is to limit and slowly ramp the current and voltage being applied to the card, similar to the way in which a power supply normally turns on. Due to the controlled rise times and fall times of the AP2182A/AP2192A, these devices can be used to provide a softer start-up to devices being hot-plugged into a powered system. The UVLO feature of the AP2182A/AP2192A also ensures that the switch is off after the card has been removed, and that the switch is off during the next insertion.

By placing the AP2182A/AP2192A between the V_{CC} input and the rest of the circuitry, the input power reaches these devices first after insertion. The typical rise time of the switch is approximately 1ms, providing a slow voltage ramp at the output of the device. This implementation controls system surge current and provides a hot-plugging mechanism for any device.

Ordering Information

Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP21X2ASG-13	S	SO-8	250/Tape & Reel	-13
AP21X2AMPG-13	MP	MSOP-8EP	2,500/Tape & Reel	-13
AP21X2AFGEG-7	FGE	U-DFN3030-8 (Type E)	3,000/Tape & Reel	-7

Enclosures

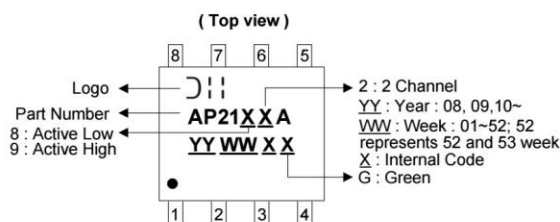
Manuals ID 06-04



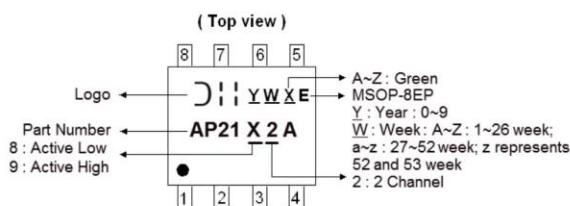
AP2182A/ AP2192A

Marking Information

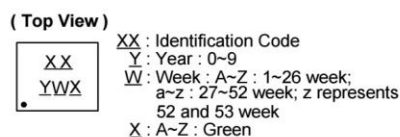
(1) SO-8



(2) MSOP-8EP



(3) U-DFN3030-8 (Type E)



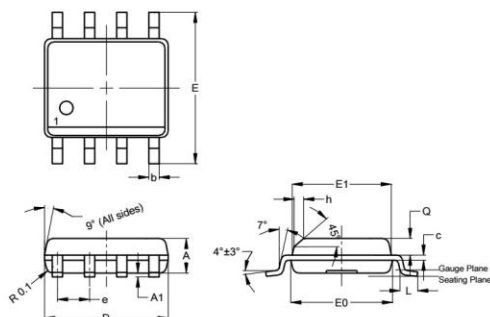
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AP2182AFGEG-7	U-DFN3030-8 (Type E)	AE
AP2192AFGEG-7	U-DFN3030-8 (Type E)	AF

Enclosures

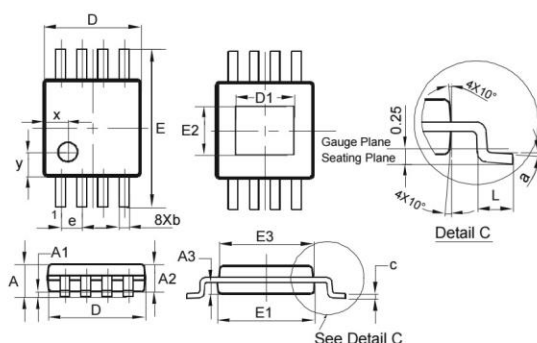
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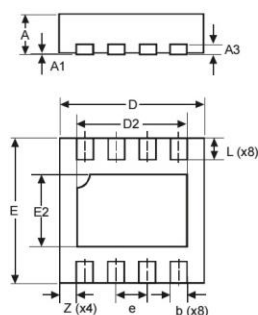
AP2182A/ AP2192A

Package Outline Dimensions (All dimensions in mm.)Please see <http://www.diodes.com/package-outlines.html> for the latest version.**(1) Package Type: SO-8**

SO-8			
Dim	Min	Max	Typ
A	1.40	1.50	1.45
A1	0.10	0.20	0.15
b	0.30	0.50	0.40
c	0.15	0.25	0.20
D	4.85	4.95	4.90
E	5.90	6.10	6.00
E1	3.80	3.90	3.85
E0	3.85	3.95	3.90
e	--	--	1.27
h	--	--	0.35
L	0.62	0.82	0.72
Q	0.60	0.70	0.65
All Dimensions in mm			

(2) Package Type: MSOP-8EP

MSOP-8EP			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
D1	1.60	2.00	1.80
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E2	1.30	1.70	1.50
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

(3) Package Type: U-DFN3030-8 (Type E)

U-DFN3030-8 (Type E)			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.20	0.30	0.25
D	2.95	3.05	3.00
D2	2.15	2.35	2.25
E	2.95	3.05	3.00
e	-	-	0.65
E2	1.40	1.60	1.50
L	0.30	0.60	0.45
Z	-	-	0.40
All Dimensions in mm			

Manuals ID 06-04

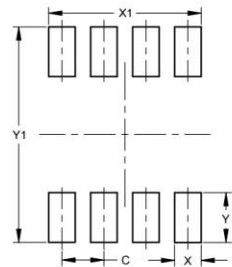


AP2182A/ AP2192A

Suggested Pad Layout

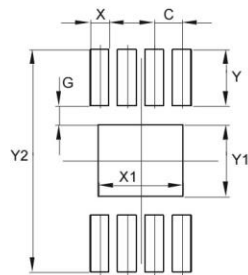
Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) Package Type: SO-8



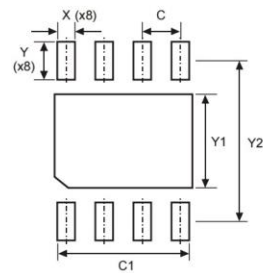
Dimensions	Value (in mm)
C	1.27
X	0.802
X1	4.612
Y	1.505
Y1	6.50

(2) Package Type: MSOP-8EP



Dimensions	Value (in mm)
C	0.650
G	0.450
X	0.450
X1	2.000
Y	1.350
Y1	1.700
Y2	5.300

(3) Package Type: U-DFN3030-8 (Type E)



Dimensions	Value (in mm)
C	0.65
C1	2.35
X	0.30
Y	0.65
Y1	1.60
Y2	2.75

Enclosures

Manuals ID 06-04



AP2182A/ AP2192A

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1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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
www.diodes.com

Enclosures

Miscellaneous ID 07-01

DRAFT CB TEST CERTIFICATE INFORMATION

Generated by BlueBox Publisher on: 2024/06/03

Product	IC Current Limiter
Name and address of the Applicant	DIODES INC SUITE 200 4949 HEDGCOXE RD PLANO TX 75024 UNITED STATES
Name and address of the Manufacturer	DIODES INC SUITE 200 4949 HEDGCOXE RD PLANO TX 75024 UNITED STATES
Name and address of the Factory(ies)	Diodes Shanghai Co., Ltd. No 1 Lane 18, San Zhuang Road, Songjiang Shanghai, 201600, P.R. China
Rating and principal characteristics	(Markings Optional) Input Voltage: 2.7 - 5.5Vdc Output Continuous Rating: 0.5A to 3.0A Output Current Limit: 1.0 to 4.8A Operating Temperature: -40C to 85C Number of Outputs: 2
Trademarks (if any)	
Model / Type ref.	AP2142A, AP2152A, AP2162A, AP2172A, AP2182A and AP2192A, may be followed by S, MP, FGE, and or additional characters that do not affect the safety features of the device.
Additional information (if necessary)	
A sample of the product was tested and found to be in conformity with	IEC 62368-1:2018 (Third Edition)
As shown in the Test Report Ref. No. which forms part of this Certificate	E322375-A6027
Client Representative	Vanessa Tien

Enclosures

Miscellaneous ID 07-01

Client email (or fax)

Vanessa_Tien@diodes.com

This form is to acknowledge that the above information has been reviewed and the material has been found to be accurate as stated. This is also to record client's confirmation that above factories manufacture product(s) that are equal to those submitted for testing and certification. (Refer to IECEE 02, Sub-clause 4.2.5: "When the application covers more than one factory, the address of each factory shall be stated in the CB Test Certificate and the NCB shall take steps to ensure that the products from all the factories are equal. That shall be confirmed in the Test Report.")

Signed: Vanessa TienDated: 6/5/2024

*Definitions per IECEE 02 (<http://www.iecee.com/cbscheme/pdf/IECEE02.pdf>):

Applicant: A firm or a person who applies to an NCB for obtaining a CB Test Certificate.

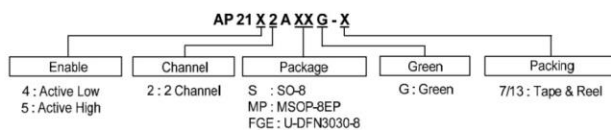
Manufacturer: An organization, situated at a stated location or locations, that carries out or controls such stages in the manufacture, assessment, handling and storage of a product that enables it to accept responsibility for continued compliance of the product with the relevant requirements and undertakes all obligations in that connection.

Factory: The location(s) at which the product is produced or assembled and follow-up service is established by the NCB.

Enclosures

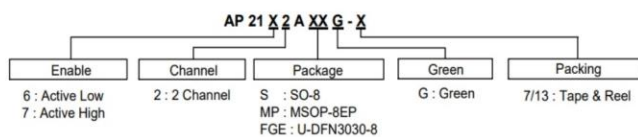
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Ordering Information



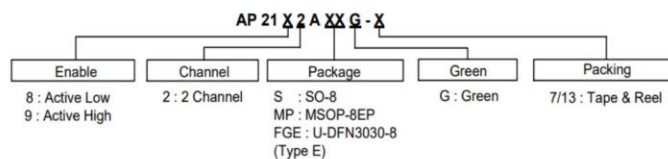
Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP21X2ASG-13	S	SO-8	250/Tape & Reel	-13
AP21X2AMPG-13	MP	MSOP-8EP	2500/Tape & Reel	-13
AP21X2AFGEG-7	FGE	U-DFN3030-8	3000/Tape & Reel	-7

Ordering Information



Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
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AP21X2AMPG-13	MP	MSOP-8EP	2500/Tape & Reel	-13
AP21X2AFGEG-7	FGE	U-DFN3030-8	3000/Tape & Reel	-7

Ordering Information



Part Number	Package Code	Packaging	7"/13" Tape and Reel	
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AP21X2AFGEG-7	FGE	U-DFN3030-8 (Type E)	3,000/Tape & Reel	-7